AD-A080 765 HONEYWELL SYSTEMS AND RESEARCH CENTER MINNEAPOLIS MN F/G 17/2
SYSTEM CONTROL FOR THE TRANSITIONAL DCS.(U)
DEC 78 F C ANNAND, M F BURKE, R K CROWE DCA100-78-C-0017
UNCLASSIFIED TR-2 SBIE-AD-E100 326 NL

1 OF 4
AD A
080765

SYSTEM CONTROL FOR
THE TRANSITIONAL DCS

TECHNICAL REPORT NUMBER 2

F.C. Annand
M.F. Burke
R.K. Crowe
D.E. Doty
S.S. McClain
R.L. Tufaner

DEFENSE COMMUNICATIONS AGENCY
DEFENSE COMMUNICATIONS ENGINEERING CENTER
1860 Wiehle Avenue
Reston, VA 22090

Under Contract DCA 100-78-C0017

December 1978

HONEYWELL INC.
Aerospace & Defense Group
Systems & Research Center
2700 Ridgway Parkway
Minneapolis, MN 55413

CONTENTS

CONTENTS (continued)

CONTENTS (concluded)

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (continued)

LIST OF ILLUSTRATIONS (continued)

LIST OF ILLUSTRATIONS (continued)

LIST OF ILLUSTRATIONS (concluded)

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF TABLES (concluded)

SECTION I

INTRODUCTION AND SUMMARY

This report describes the results of the second portion of the System Control for the Transitional Defense Communications System study. The objective of this study is to define a system to assist in responding to stresses of the DCS requiring system wide visibility as can be provided at Theatre/ACOC. Peace time, minimal stress scenarios are emphasized. (See the first technical report for the scenarios considered.)

The work summarized in this report has addressed the acquisition of data which permits stress detection and isolation and the correlation and display of these data at ACOC. This work, and that reported on in Technical Report No. 1, comprise task 1 of the study. The second task will address the selection and activiation of system level controls in response to detected stresses.

1.1 STUDY BASELINE

The focus of the study is the DCS anticipated to exist in Europe in the mid 1980's. The European DCS is used because it is as complex as any other segment of the DCS and contains examples of every type of subsystem used in the DCS. The European area is reflective of user and mission objectives world wide. Results can be extended to other theatres. The European DCS of the mid 1980's is assumed to consist of:

- A Digital European Backbone using microwave radios and multiplex equipment compatible with the DRAMA specifications and digital

tropo-scatter radios and monitored by an ATEC system consistent with the ESD ATEC 10000 specification.

- The Defense Satellite Communication System (DSCS) using the DSCS III satellite and under the control of equipment specified in the DSCS Control Segment (CS) specifications.
- An integrated AUTOVON/AUTOSEVOCOM II system using TTC-39 switches and SB-3865 concentrators.
- An AUTODIN II System using three switches identical to those being developed for use in CONUS, to replace the existing AUTODIN switches.

The TTC-39 and SB-3865 were planned for upgraded AUTOVON/AUTOSEVOCOM II at the time this study was started. The decision not to use these equipments occurred after this work was completed.

The first technical report described the configuration of these systems in Europe used as the baseline for this study. Appendix A of this report summarizes significant characteristics of these systems.

1.2 RECOMMENDED SYSTEM CONTROL SYSTEM

A system integrating the control capabilities of the subject subsystems has been recommended. The data gathering capabilities of each subsystem have been used to provide data necessary for system level control of the DCS. Particularly, the data must support detection, isolation, and response to

system level stresses. Thus, correlation to detect and isolate stresses beyond that done at lower levels of the DCS hierarchy is required. This includes correlation of reports from multiple AUTOVON switches, and between the switched networks and the transmission network.

Specific CRT displays are provided which highlight the cause of the stress rather than merely presenting all of the stress indications. Additional CRT displays provide the comprehensive status and current allocation of the DCS resources. These support the selection of appropriate controls to minimize the impact of the stress.

The software and a host computer system to support the data correlation and displays at ACOC level have been characterized. In addition, the modifications to planned subsystems in order to acquire the necessary data and the means of telemetering that data to ACOC have been characterized. ATEC, DSCS CS, and AUTODIN II are planned to report data to ACOC, therefore requiring little change.

For ATEC and the DSCS CS, it is recommended that changes in status of special interest circuits, trunks. links and stations be made upon completion of fault isolation, which is more an elaboration of operating policy, than a change to those subsystems. This will make available to the System Controller comprehensive system status.

For AUTODIN II, a Subnetwork Control Center, which is a copy of the Network Control Center is recommended for use at ACOC Europe.

This will permit focussed attention on the operation of European AUTODIN II, and will allow continued control of that network even when isolated from CONUS.

Acquisition of data from the TTC-39 is recommended to be via the SYSCON channel and a channel acquisition equipment. This will be either a Channel Reconfiguration Model or a SYSCON Channel Acquisition Unit. All channels are collected at a central site where they are routed into a Report Consolidation Processor, and then onto a dedicated circuit to ACOC.

The SB-3865 is modified to provide messages defined by ICD-004 in an ATEC format. These messages are routed into an ATEC Communications Interface Set (CIS) and through ATEC to ACOC.

Budgetary estimates of the costs of the required equipment and modifications have been made. These are summarized in Table 1-1.

The recommended system and supporting analyses are described in the balance of the report.

1.3 REPORT OVERVIEW

Section II is a functional description of the recommended system. It includes a summary of the philosophy of real time system level control of the DCS which guides this study. It then describes the components of the

TABLE 1-1. BUDGETARY COST SUMMARY

SYSTEM/SUBSYSTEM	NON-RECURRING NEW HARDWARE DEVELOPMENT		RECURRING (OFF THE SHELF) HARDWARE Costs $	SOFTWARE Cost Labor (Man-days)
	Labor (Man-days)	Costs Material $		
AUTODIN II SNCC	-	-	-	5
SB-3865	118	700	56,500	80
TTC-39	-	-	-	18
SCAU	175	1,000	22,500	-
RCP	-	-	19,950	100
DSCS TCE	-	-	-	40
DSCS NCE	-	-	-	35
ATEC CIS	-	-	-	5
ATEC NCS	-	-	-	46
ATEC SCS	-	-	-	40
ACOC/WWOLS	-	-	91,465	3096

recommended system, how they are integrated, the ACOC level displays, and the supporting algorithms. Finally, scenarios demonstrating the use of the system are presented.

Section III presents the design rationale. Particular subjects include the subsystem interfaces and telemetry for AUTOVON, the use of a Subnetwork Control Center for AUTODIN II in Europe, and the integration of the DSCS Operational Control function into the recommended ACOC level system. Finally, the contents of the required data bases are described.

Section IV presents the Functional design of the software and hardware required for the recommended system. It concludes with the sizing and costing of that software and hardware.

Section V contains the analysis of the parameters available from each subsystem and the selection of those required at ACOC for system level control. The resulting information flow is also analyzed.

Appendix A describes the aspects of the DCS subsystems being considered which are important to System Control. Particularly, data available and controls which may be remotely executed are identified.

Appendix B provides the detailed results of the software sizing.

Appendix C describes events associated with four stress scenarios. This illustrates how the system will respond to stresses.

SECTION II

SYSTEM FUNCTIONAL DESCRIPTION

2.0 INTRODUCTION

A functional description of the proposed System Control, integrating the mid 1980's subsystem, is presented in this section. The first subsection summarizes the philosophy of real-time system level control which guides this study. This philosophy is the basis for selecting the data reported, the algorithms, the displays, and the data base for the recommended system.

The second subsection describes the components of the total System Control system and how they are integrated to provide the information flows required.

The third subsection summarizes the displays proposed for use at ACOC. These are presented here because they define the information required by the controllers in order to make control decisions. Therefore, they define the data which must be sent to ACOC, the processing required to reduce the data to its most usable form, and data bases required in the course of that processing. Note that the next task of the study will investigate how the control decisions can be aided by automation. The same information will be necessary for the automated decisions, so that the results of the current task will not be significantly impacted.

The performance assessment, stress detection, and stress isolation algorithms which support the displays are described in the fourth subsection.

Finally, the operation of the proposed system is demonstrated via several scenarios tracing events from the initial outage through informing the operator who must take action.

2.1 SYSTEM CONTROL PHILOSOPHY

The purpose of this study is to define a System Control system for the DCS which will provide a capability for rapid restoral of critical user circuits. The general control philosophy we are following is to permit accomplishment of System Control functions at the lowest feasible levels in the control hiearchy. Then, as problems occur which can't be handled at a particular level, they will "bubbleup" as high as required for resolution.

The capability for real time System Control already exists or is being developed for the System Control elements below the Theatre level. Therefore, this study is oriented to solving those real time System Control functions which reach the Theatre level (ACOC).

The Theatre level System Control activities envisioned in the area of Network Connectivity Control will occur in response to a request from Sector level personnel for assistance in handling an outage. This will occur if a Critical Restoral Plan is not applicable in a stress situation. The Theatre level will revise the restoral plan to fit the current situation with the assistance of its computer system. The recommended restoral will be sent to the Sector. The Sector will direct the connection of the alternate circuit and test it before it is placed in service.

The Theatre level will also generate restoral plans, again assisted by the computer system. It may revise those plans as necessitated by the current status of the communication system.

The functions of selection or modification of restoral plans are direct extensions of the circuit allocation function already performed at the Theatre. Therefore, the personnel there have the requisite training for these tasks. The data required for these functions are the configuration and status of the transmission system resources.

The Theatre level AUTOVON control functions envisioned include the ability to test restoral plans before they are actually implemented. This would use a model of AUTOVON which could be configured to represent the proposed restoral plan. The model would then be exercised to determine its performance. The data required for this function are the configuration, status and loading of the AUTOVON as provided by the recommended system.

2.2 THE COMPONENTS OF THE SYSTEM CONTROL SYSTEM

The components which are integrated by the recommended system are shown in Figure 2-1. These are the equipments expected to be used in the mid 1980's DCS. They include:

- o The AUTODIN II Network Control Center (NCC), a recommended Sub-network Control Center (SNCC) which is a copy of the NCC supervising the European AUTODIN II system only, and the Packet Switching Node.

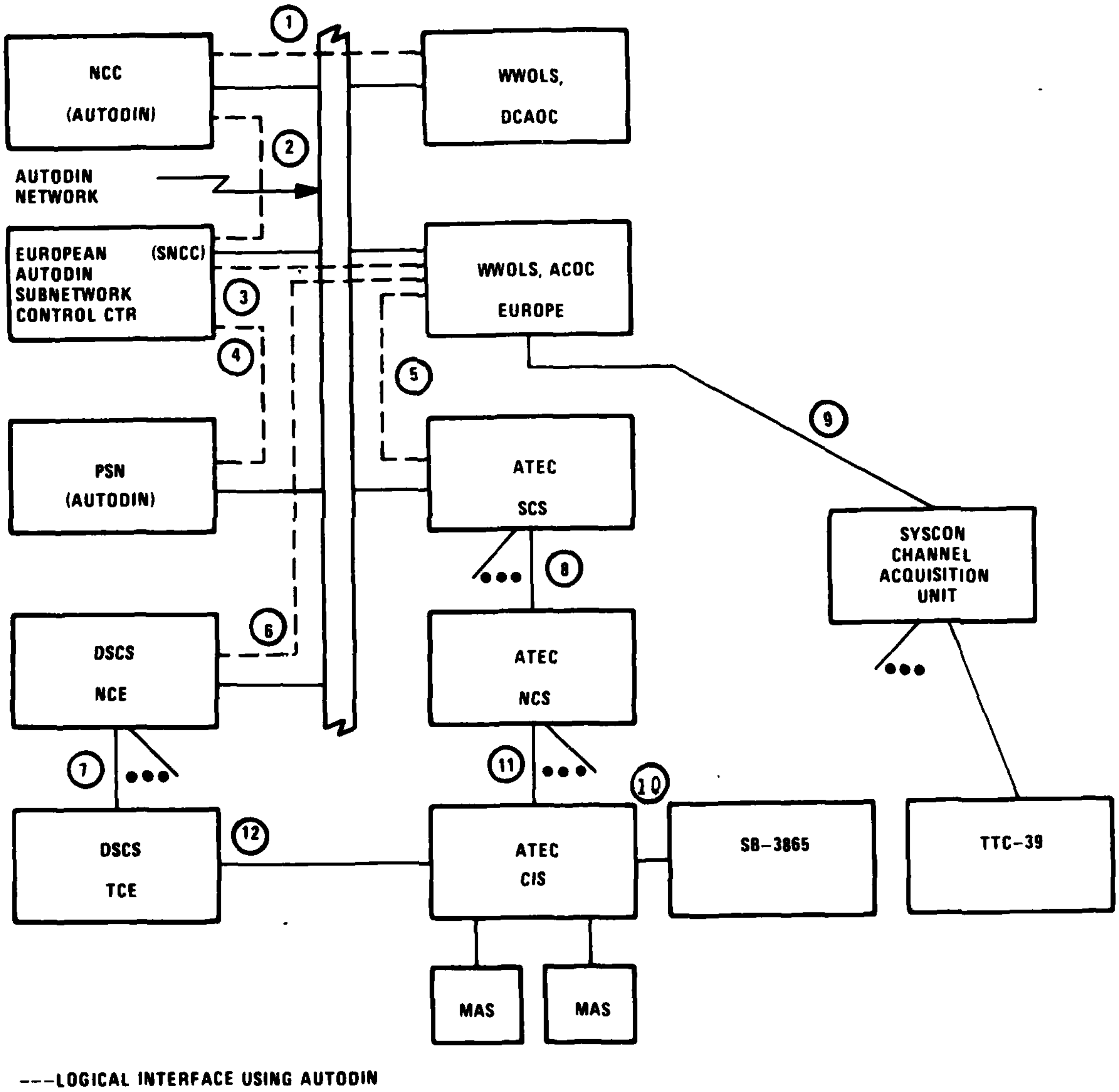


Figure 2-1. SYSCON Components

- o The DCAOC where world wide DCS control is exercised.
- o The ACOC where Theatre wide control is exercised and the level at which system wide control can be exercised.
- o The Upgraded AUTOVON/AUTOSEVOCOM II components (the TTC-39 and SB-3865).
- o The ATEC components - the Sector Control Subsystem (SCS), Nodal Control Subsystem (NCS), the Communications Interface Subsystem (CIS) and the Measurement Acquisition Subsystem (MAS).
- o The DSCS Control Segment Components - the Network Control Element (NCE), and the Terminal Control Element (TCE).

The Operations Control Element (OCE) of the DCSC Control Segment has been integrated into the Network Connectivity Control function implemented in WWOLS, and is, therefore, not shown as an individual component.

Two components shown have been added to facilitate the interfaces to the AUTOVON components. These are the SYSCON channel acquisition unit (SCAU) and the Report Consolidation Processor (RCP).

The interfaces between all of the components are discussed briefly in the following sentences. Those which are already specified are not discussed further, while the new or changed ones are discussed further in Section III.

1. NCC/DCAOC - This is planned as part of DIN II and WWOLS upgrade. It supports 55-1 reporting by DIN II. No added data flow has been recommended.

2. NCC/SNCC - This is a new interface which uses DIN II. It forwards European PSN reports to NCC and handles NCC/SNCC communications. Contents of the connection are:

   o PSN/NCC messages from three switches.
   o SNCC/NCC intercommunications.

3. SNCC/WWOLS (ACOC EUR) - This is a new interface which uses DIN II. This interface method was chosed because both units are anticipated to have DIN II connectivity and will, therefore, be compatible. This connection handles the European subset of the data transferred across interface 1 above. Data flow supports:

   o Stress isolation (data to WWOLS identifies transmission faults identified by DIN, data from WWOLS identifies transmission faults identified by ATEC and the DSCS-CS).
   o Requests for added transmission service from SNCC.
   o Grants of added transmission service from WWOLS.

4. SNCC/PSN - This interface is the same as the standard DIN II data flow from PSN to NCC.

5. ATEC SCS/ACOC, EUR - This interface is defined by the ATEC 10000 specifications although the contents are not specified there. Besides reporting the ATEC results, the SB-3865 switch data will also flow across this interface.

6. DSCS NCE/ACOC - This interface is effectively the NCE/OCE interface described in the DSCS CS specification, since the OCE function has been integrated into

ACOC/WWOLS. Details of interface and data content are not specified by the DSCS CS. Use of ADCCP protocols is recommended. The DSCS CS specification permits the OCE to request any data from the NCE's it interfaces, and may send requests for transmission service to the NCE. A recommended addition is to report by exception on failures of significance to Theatre level control.

7. DSCS NCE/DSCS TCE - This interface is specified in the DSCS CS specification. Data flow is per the specification.

8. SCS/NCS - This interface is specified in the ATEC 10000 specification. Additional data which will pass over it is SB-3865 reports and directives. The data which already passes over it for ATEC is not expected to change.

9. TTC-39/SYSCON Channel Acquisition Unit and Report Consolidation Processor - This is a new interface to route TTC-39 messages and directives through the System Control hierarchy. A special unit to intercept messages from the SYSCON channel of the interswitch trunks is required. This could be a Channel Reconfiguration Unit or hardware specifically serving this purpose. All of these units will be at the Langerkopf switch. A Report Consolidation processor will accept the SYSCON channels and forward them to ACOC. See Section III for details.

10. SB-3865/ATEC CIS - This is a recommended interface to gather SB-3865 data into System Control. IDC-004 messages and an ATEC interface protocol is used. See Section III for details.

11. ATEC NCS/ATEC CIS - This interface is included in the ATEC 10000 specification. It will now carry SB-3865 data as well as normal ATEC data.

12. DSCS TCE/Terrestrial Node or Station - This interface is described in DSCS/CS specifications. Voice and data orderwires are provided by the terrestrial DCS. It will be used for local DSCS/terrestrial DCS coordination and also to interface the Terminal Control Processor in the DSCS TCE to an ATEC CIS.

2.3 DISPLAYS AT ACOC

The CRT displays defined for ACOC Network Connectivity and AUTOVON Control were developed by a combination of techniques. These included studying the displays to be used in the ATEC system, the AUTODIN II Network Control Center and the development of a status file at ACOC upon receipt of 55-1 status reports. Also, the data available from the ATEC system, the DSCS Control Segment, the TTC-39 switch and the ULS was evaluated. In addition, various stress scenarios were analyzed to determine that the data required to fully inform the controller are available. See the last subsection of this section for examples of several scenarios.

The following subsections describe the displays to support AUTOVON/AUTOSEVOCOM Control and Network Connectivity Control.

2.3.1 AUTOVON/AUTOSEVOCOM Displays

A hierarchy chart of the displays provided for the AUTOVON controller is shown in Figure 2-2. Included in the hierarchy are only those displays dealing with the real time System Control functions. Other, more general man/machine interface functions also exist, but they are not being defined here. The hierarchy of displays and the display formats are similar to those provided for AUTODIN II. Although these networks may have different controllers, the similarity of display presentation could reduce training requirements for network operators. The AUTODIN II displays do provide access to large amounts of information using a standard keyboard/display terminal. The top display in the AUTOVON display hierarchy, shown in Figure 2-3, is a summary of the entire system status. It is a very simple display which indicates either normal (shown as +) conditions or a basic anomaly in traffic, switch equipment, trunk status, user access status, or switch messages. Its prime purpose is to provide an overview of the entire system and direct the controller to more detailed displays at lower levels in the hierarchy. The categories shown in the summary display correspond to the categories at the next level in the display hierarchy.

The traffic status summary (Figure 2-4) shows the overall state of network performance at each switch. The categories reported on are the following:

- o Priority calls - the network is specified to be Flash non-blocking. If a Flash or higher precedence call is blocked, the area controller must be made aware that the network has failed.

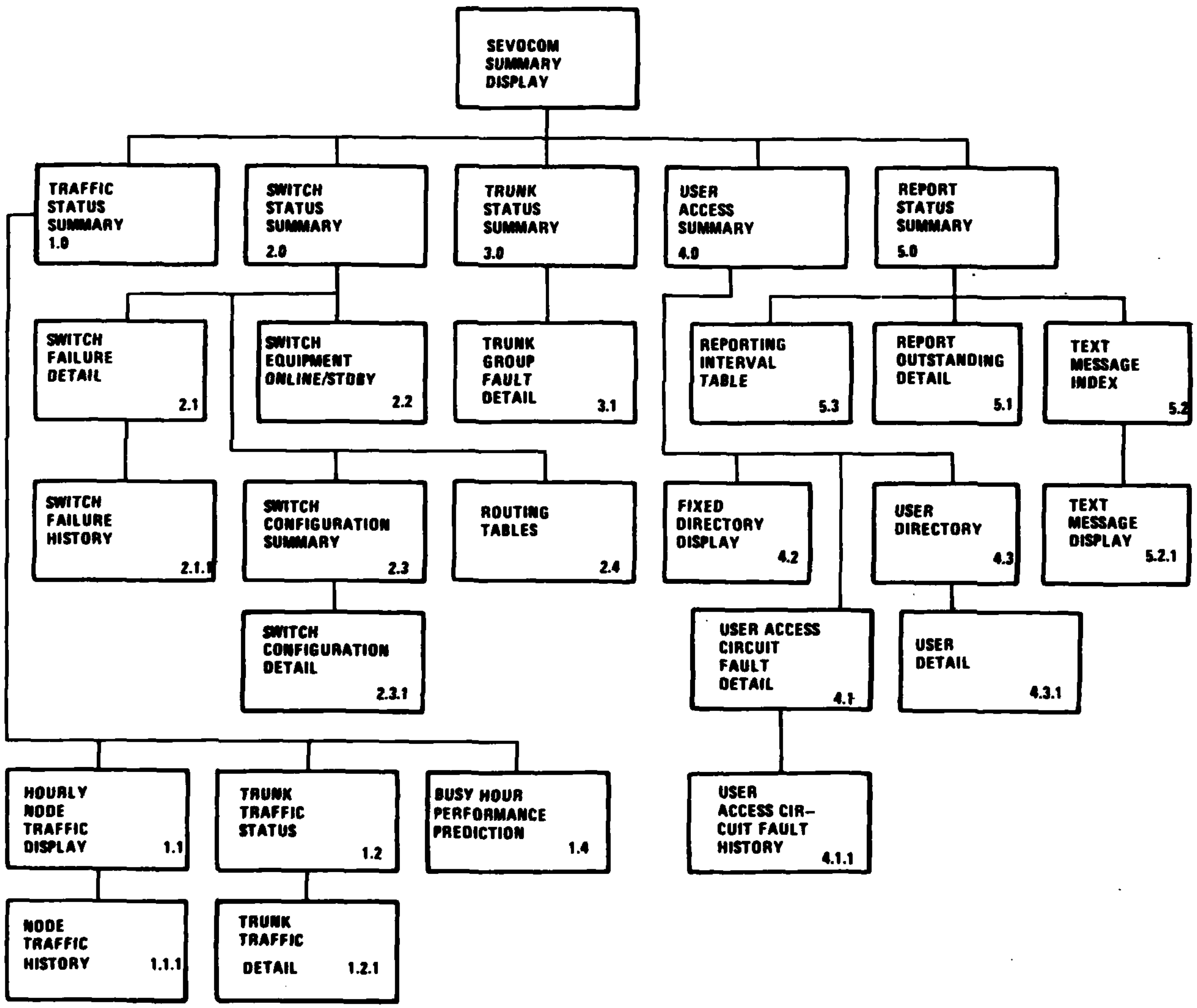


Figure 2-2. AUTOSEVOCOM/AUTOVON Display Hierarchy

	HIN	MAM	SCH	FEL	DON	LKF	CTO	MRE	HUM
TRAFFIC	+	+	+	+	+	+	ALARM	+	+
SWITCH EQUIPMENT	+	HAZ	+	+	+	+	+	+	+
TRUNKS	+	+	+	+	+	+	+	+	+
USER ACCESS	+	+	+	ALARM	+	+	+	+	+
MESSAGES	+	+	+	D•DUE	+	+	+	+	+

Figure 2-3. Network Status Summary Display

	HIN	MAM	SCH	FEL	DON	LKF	CTO	MRE	HUM
PRIORITY CALLS	+	+	+	+	+	+	ALARM	+	+
DIAL TONE DELAY	+	WARN	+	+	+	+	+	+	+
TRUNK BLOCKING	+	+	+	+	+	+	+	+	+
COMMON EQUIPMENT BLOCKING	+	+	+	9	+	+	+	+	+
PROCESSOR LOAD	+	+	+	WARN	+	+	+	+	+

Figure 2-3. Network Performance Summary Display

- O Dial tone delay - The dial tone delay is one indicator of local switch congestion. By being aware of local switch conditions, the area controller can avoid making control actions which would aggravate the local conditions.
- O Trunk blocking - The basic traffic measurement in the network.
- O Common equipment blocking - Another indicator of local congestion.
- O Processor load - Total processor load must be maintained below 100%. If local controls cannot keep processor utilization down, area level must take some action to do so.

More details on the traffic are obtainable by examining the hourly node traffic summary (Figure 2-5) and its history file. This display breaks out the calls processed by the switch by the source of the call. It is used by the controller to determine whether or not routing controls can alleviate switch stress.

The trunk traffic status (Figure 2-6) shows the basic traffic parameters on each trunk group in the network. It is detailed backup for traffic overload alarms which the controller might wish to examine before taking control actions. Even greater detail is provided by the trunk traffic detail display (Figure 2-7). This display breaks out by precedence how many calls were attempted, blocked, and preempted, and the cause of the blockage.

The preformance prediction display (Figure 2-8) uses the current network configuration and the normal busy hour traffic demand to show busy hour node-node Grade of Service. By examining this display, the controller can quickly determine where the weak points in the network are, and whether or not they are within acceptable performance ranges.

	HIN	MAM	SCH	FEL	DON	LKF	CTO	MRE	HUM
LOCAL	82	250	78	160	124	136	44	80	148
ORIGINATING	404	322	192	685	658	724	252	259	326
TERMINATING	305	287	222	734	906	700	098	220	294
TANDEM	1720	55	2	1580	504	74	5	945	

Figure 2-5. Hourly Node Traffic Summary Displays

1.2 TRUNK TRAFFIC STATUS PAGE 1 OF 2

	HIGH PRIORITY GOS	ATB	OFFRD	UTIL	*	TOTAL GOS	ATB	OFFRD	UTIL
HIN-FEL	000	000	7	.070		086	21	238	.728
HIN-MAM	000	000	6	.140		000	0	251	.371
HIN-LKF	000	000	3	.073		017	3	154	.546
HIN-DON	000	000	10	.071		502	165	328	.831
HIN-HUM	000	000	2	.200		043	6	129	.593
MAM-FEL	000	000	4	.100		011	2	137	.465
MAM-DON	000	000	16	.077		304	129	424	.861
SCH-FEL	000	000	4	.077		009	1	132	.506
SCH-DON	000	000	6	.083		063	12	183	.669
SCH-LKF	000	000	5	.125		075	8	99	.569
FEL-MRE	000	000	0	.050		081	3	37	.781
FEL-DON	000	000	27	.077		191	157	820	.895
FEL-LKF	000	000	19	.077		100	64	622	.835
FEL-CLO	000	000	5	.091		059	9	156	.627
DON-MRE	000	000	4	.071		046	10	209	.663

***** CONTINUED ON PAGE 2

Figure 2-6. Trunk Traffic Status Display

TRUNK TRAFFIC DETAIL HIN-FEL

	FLASH OV	FLASH	IMMEDIATE	PRIORITY	ROUTINE
GOS	000	000	000	000	000
OFFERED	2	5	127	59	45
NO IDLE TRUNK	000	000	28	14	11
NO COMMON EQUIP	000	000	000	000	000
PREEMPTIONS	000	1	28	14	11
PREEMPTIONS BLOCKED	000	000	3	7	11

Figure 2-7. Trunk Traffic Detail Display

PFRFORMANCE PREDICTION - BUSY HOUR

	CDB	POT	HIN	MAM	SCH	FEL	DON	LKF	CTO	MRE	HUM
CDB	\		.48	.48	.48	.48	.50	.49	.49	.49	.48
POT		\	.48	.49	.49	.49	.51	.50	.50	.50	.50
HIN	.45	.45	\	.00	.00	.00	.05	.01	.01	.03	.00
MAM	.47	.47	.00	\	.03	.00	.04	.00	.02	.00	.00
SCH	.35	.35	.00	.03	\	.00	.03	.02	.02	.02	.00
FEL	.43	.43	.00	.00	.00	\	.03	.02	.02	.02	.00
DON	.54	.54	.05	.04	.00	.03	\	.00	.01	.	.00
LKF	.49	.49	.00	.00	.00	.02	.00	\	.02	.01	.00
CTO	.57	.57	.01	.02	.01	.02	.01	.01	\	.01	.01
MRE	.47	.47	.03	.00	.01	.02	.00	.01	.00	\	.00
HUM	.36	.36	.00	.00	.00	.01	.00	.00	.00	.00	\

Figure 2-8. Performance Prediction - Busy Hour Display

The next major category of displays is the switch equipment displays. The switch equipment failure summary (Figure 2-9) provides the controller the status of all switch equipment at a glance. Items with standby redundancy show either (+) for nominal condition, (HAZ) for hazardous condition i.e. single failure, or (ALARM) for complete failure. Items of common equipment have the number of failed equipments followed by the number of total equipments so that, for example, in Figure 2-9 there is one of four trunk signalling buffers failed at Schoenfeld. If the entire common equipment function is lost, the display indicates alarm, as is shown for LKG's at Donnersberg in Figure 2-9. Details of any failure are obtainable from lower level files.

The switch failure detail (Figure 2-10) contains a log of all recent failure messages for a given switch, along with an analysis of the effect on the network. The switch failure history file (Figure 2-11) accumulates the operational and nonoperational times for equipment items and displays basic statistics related to these times. By referencing this display, the controller can see how long it usually takes the local switch personnel to restore or repair the item. Some judgement can then be made as to whether or not take centralized control actions. If the network is not too badly impaired and the fault type is normally restored quickly, no action at ACOC is justified.

The switch equipment online and standby is similar to the switch status summary, except that the actual numbers of equipments are used rather than generalized symbols. It is more difficult to get a general idea of network status from this display because of its extra detail, but it is needed for that same reason.

SWITCH EQUIPMENT FAILURE SUMMARY

	HIN	MAM	SCH	FEL	DON	LKF	CTO	MRE	HUM	
PRIME POWER	+	+	+	+	+	+	ALARM	+	+	
CPU	+	HAZ	+	+	+	+	+	+	+	
SIG BUFF CNTRLLR	+	+	+	+	+	+	+	+	HAZ	
TENLEY CNTRLLR	+	+	+	+	+	+	+	+	+	
SW CNTRLLR GRP	+	+	+	+	+	+	+	+	+	
MASTER TIMING	+	+	+	+	+	+	+	+	+	
TRNK SIGNL BFFR	+	+	1-4	+	+	+	+	+	+	
DIGITAL RCVRS	+	+	+	+	+	+	+	+	+	
DTMF RECEIVERS	2-13	+	+	+	+	+	+	+	+	
MF RECEIVERS	+	+	+	+	+	+	+	+	+	
DTMF/MF SENDERS	+	+	+	+	+	+	+	+	+	
IMU	+	+	+	+	+	+	+	20-105	+	
LKG				+	+	+	+	ALARM	+	+

Figure 2-9. Switch Equipment Failure Summary Display

SWITCH EQUIPMENT FAILURE DETAIL - HUMOSA

STATUS	EQUIP ID	INTIAL REPORT TIME	LAST REPORT TIME	ONLINE	STANDBY	FAILED
HAZCON	SBC	2341	2341	1	0	1
SECURITY	LKG	0105	0105	0	-	48
	DGTL RCV	2206	0047	3	-	5

Figure 2-10. Switch Equipment Detail Display

SWITCH EQUIPMENT FAILURE HISTORY - HUMOSA

	FAILURE RATE	AVERAGE RESTORAL TIME	AVERAGE REPAIR TIME	NO. FAILURES/TOTAL TIME DAILY	MONTHLY	YEARLY
PRIME POWER	.001	40	40	0/0	1/73	1/73
CPU	.0001	0	35	0/0	0/0	1/30
SIG BUFF CNTRLLR						
TENLEY CNTRLLR						
SW CNTRLLR GRP						
MASTER TIMING						
TRNK SIGNL BFFR						
DIGITAL RCVRS						
DTMF RECEIVERS						
MF RECEIVERS						
DTMF/MF SENDERS						
IMU						
LKG						

Figure 2-11. Switch Equipment Failure History Display

The switch configuration summary contains basic information from the local switch data base such as the routing table, the status of traffic controls, and the call inhibit tables. This display is referenced by the controller to determine the switch configuration before initiating controls to modify it. The controller would otherwise have to remember all deviations from normal network configuration.

The trunk status summary (Figure 2-12) provides an overall summary of trunk faults and traffic overloads. By referencing this display, the controller can immediately determine what transmission resources are available. For any alarmed trunk group, a trunk group fault detail display (Figure 2-13) is available which holds the last 12 change reports (or the past 24 hours worth) referring to the trunk group.

The user access display group contains the status of critical subscriber's access circuits. The report status summary display indicates the presence of text messages and reports overdue from the switches. The report interval table displays the time between schedule reports, and the report outstanding detail display shows any reports that are overdue. Text messages are available from the text message display.

2.3.2 Network Connectivity Displays

The displays provided to communicate Network Connectivity related information to the operator are listed in Figure 2-14. The information contained in these displays includes the current status of the transmission system, reporting status, and an inventory of transmission system resources (i.e., channels) and their use. The transmission system and reporting status dis-

TRUNK STATUS SUMMARY

TRUNK TO

		CDB	POT	HIN	MAM	SCH	FEL	DON	LKF	CTO	MRE	HUM
R	CDB	\		ALARM			OLOAD				+	
E	POT		\	ALARM			OLOAD				+	
P	HIN	ALARM	ALARM	\	+		+	+	+			+
O	MAM			+	\		+	+				
R	SCH					\	+	+	+			
T	FEL	OLOAD	OLOAD	+	+	+	\	+	+	+	+	
E	DON			+	+	+	+	\	+	+	+	+
D	LKF			+		+	+	+	\		+	
	CTO						+	+		\	AMBER	
B	MRE	+	+				+	+	+	AMBER	\	+
Y	HUM			+				+			+	\

Figure 2-12. Trunk Status Summary Display

TRUNK GROUP FAULT DETAIL **DON-LKF**

DIGITAL TRUNKS-0 GREEN/8 TOTAL

STATUS	FAULT TYPE	ERROR RATE	XMISSION STATUS	REPORT TIME	CLEARED TIME
ALARM	TCG O/S	O/S	ALARM	1523	
WARN	FIFO	2	TREND	1522	
WARN	RESYNC	3	TREND	1407	1407
WARN	RESYNC	3	O/K	1238	1238

ANALOG TRUNKS-4 GREEN /12 TOTAL

STATUS	FAULT TYPE	SGNLG STATE	XMISSION STATUS	REPORT TIME	CLEARED TIME
WARN	-	INBAND	O/K	1528	
ALARM	TGC O/S	CCS-U	O/K	1523	1528

Figure 2-13. Trunk Group Fault Detail Display

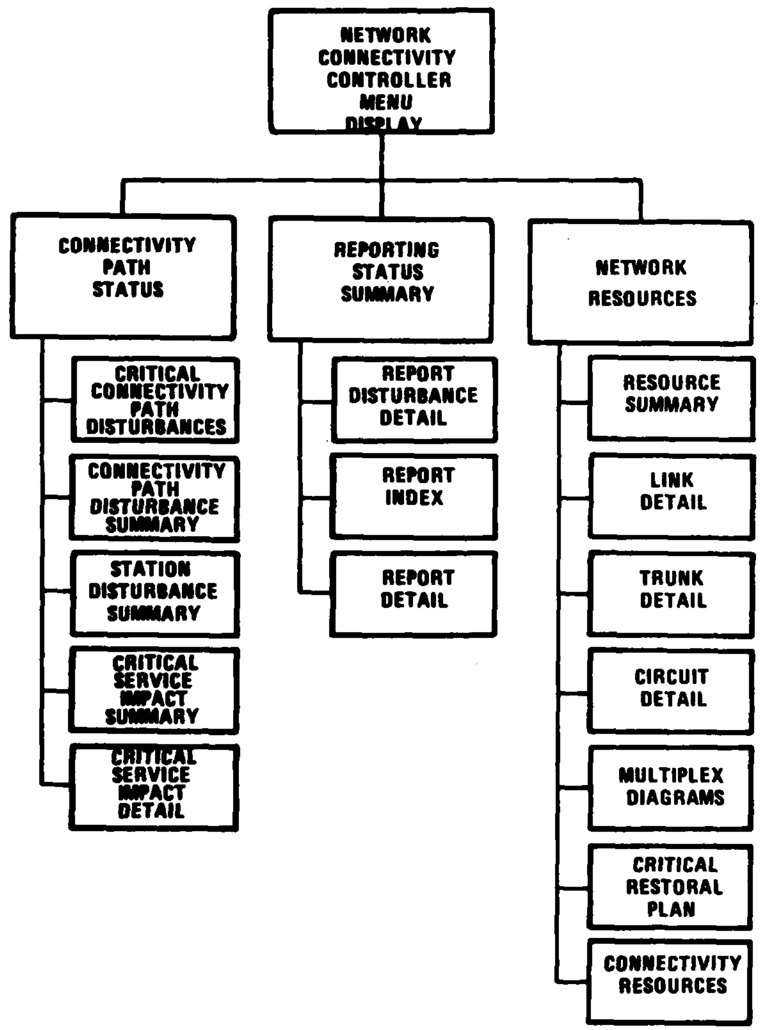


Figure 2-14. Network Connectivity Controller Display Hierarchy

plays are the means for conveying the results of performance assessment, stress detection, and isolation. The inventory is essential for selecting control actions. These displays are described in the following paragraphs.

Connectivity Path Status--This display summarizes the status of the entire European backbone. It is modeled after the connectivity path displays used by ATEC to convey an end-to-end path defined by a set of connecting links. The proposed connectivity paths to be used for overall Europe are those which interconnect all pairs of backbone branch points and major nodes (specifically switches). A graphical representation of this display using standard alphanumeric symbols is shown in Figure 2-15. In this display there has been a failure at Rhein Main. The use of a flashing pound sign and station identifier would highlight this problem. The [P] indicates that this is a partial failure affecting the DON-RMN link. Further detail on this fault can be called up by the operator. This would be the connectivity path disturbance detail, discussed below.

Disturbances to tails off of the backbone will be indicated on this display. Also, station level faults and hazardous conditions can be indicated. Note that this display combines terrestrial and DSCS transmission resources.

Critical Connectivity Path Disturbances--The Critical Connectivity Path Disturbances display is a list of all connectivity path disturbances which have interrupted critical subscribers. The distinctions between it and the connectivity path status display described above are: 1) that it lists only the facilities or capabilities which have reported disturbances, and 2) that it orders the disturbances by the extent of critical service interruption and

CONNECTIVITY SUMMARY

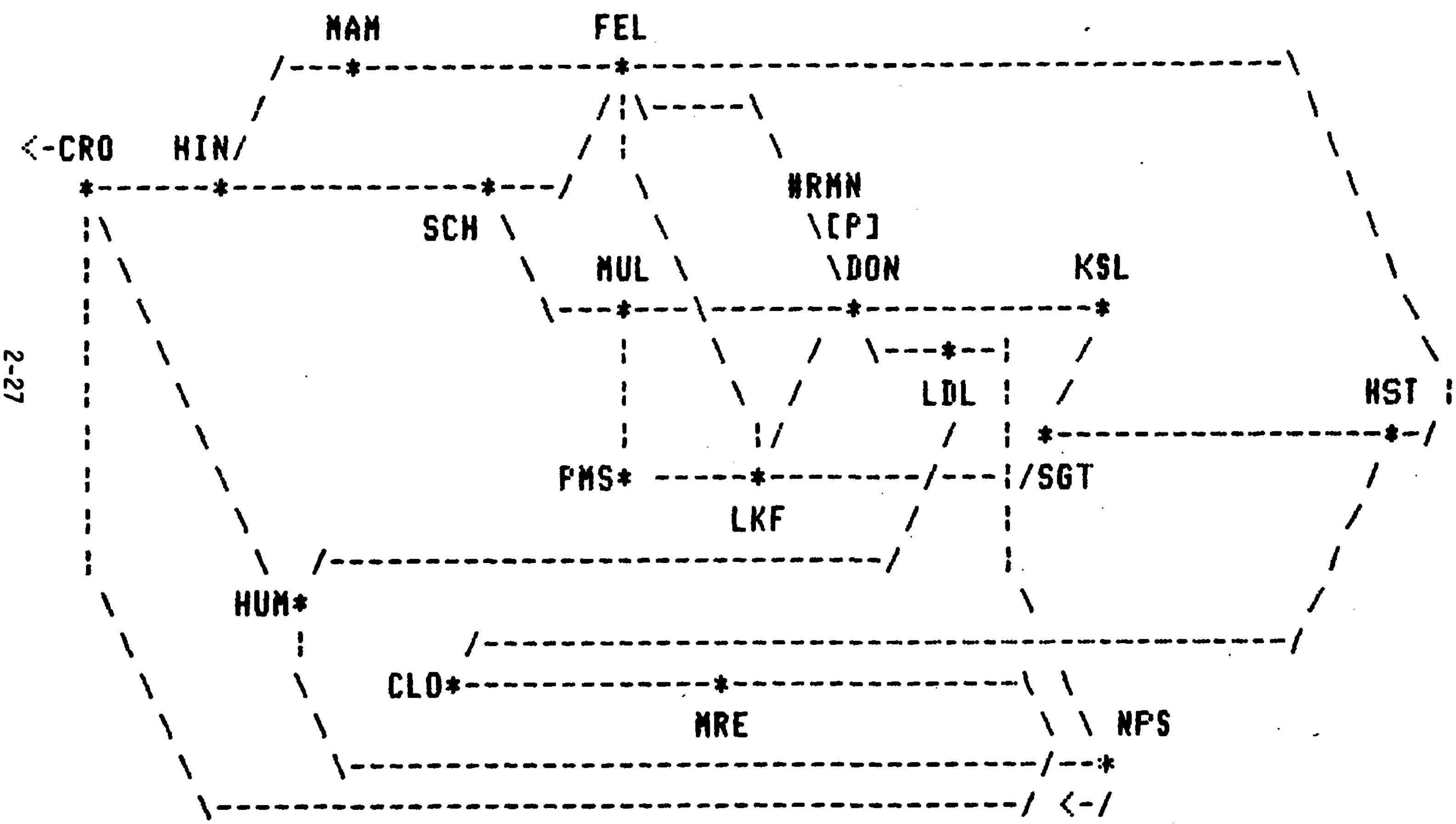


Figure 2-15. Connectivity Summary Display

elapsed time of the interruption. This display also permits accessing the Connectivity Path Disturbance Detail.

Connectivity Path Disturbance Detail--An example of this display is shown in Figure 2-15. This is based on the ATEC displays (ATEC 1000 specification). It includes a graphical presentation of the connectivity path identifying the terminating facilities for any failure/disturbance. The highest restoration priority (RP) out of service (OOS) is listed. Beneath this is a line for each report related to the disturbance. In the example, based on scenario 9, report number 6 indicates a group level disturbance (Severity (SEV) = GP). The degree (DEG) of the disturbance is Red (R). The Ident of the group is 44 JM09. The locations reporting the outage are Donnersberg and Feldberg (The group is out in both directions.) The disturbance is on Super Group B, Group 7. All channels are affected. Comments indicate that the cause is equipment at Donnersberg. This indicates that the reason for outage has been sent to ACOC. The initial report is the output of automated fault isolation, and would not include an RFO, though it could include the location of the fault. The estimated time to repair the fault is 30 minutes, and the time that the report was made is 0730.

The other report line is a later report indicating that Group 7 is also out of service. At the time of this report, no comments on the ETR have been reported.

DON—FEL CONNECTIVITY PATH DETAILS

DON ——— M0372 ——— RMN ——— M0375 ——— FEL   HIGHEST RP OOs: 2

2 GRPS – R   2 GRPS – R

RPRT NO.	DEG	SEV	IDENT	LOC	SG	G	CH	COMMENTS	ETR	TIME
12	R	GP	44JM08	DON/ FEL	B	6	ALL			0748
6	R	GP	44JM09	DON/ FEL	B	7	ALL	EQPT—DON	0030	0730

ENTER NUMBER TO OBTAIN DISPLAYS LISTED BELOW 3

[1] CONNECTIVITY PATH SUMMARY

[3] CIRCUIT IMPACTED

Figure 2-16. Connectivity Path Detail Display

The complete report can be obtained by calling up the Report Detail display for the report.

Station Disturbance Summary--This display will include summary lines for all disturbance reports from a specific station. These lines are the same as in the Connectivity Path Disturbance Summary. The only difference is that all these from a particular station are grouped.

Impact Summary--This is a list of the number of special interest and priority one and two circuits of each type of service which are out of service due to a disturbance. See Figure 2-17.. This display will be updated whenever a circuit is restored to service via altrouting. This display gives a quick summary of the impact of a disturbance.

Impact Detail--This is a list of special interest and priority one and two circuits out of service due to a disturbance. It is used to identify specific circuits impacted or to select specific circuits for reporting.

Reporting Disturbance Summary--This display identifies any Sectors or NCEs which have not submitted reports to ACOC on schedule. This includes keep alive reports required to assure that communications to Sectors and NCEs have not been disrupted. The display also identifies any Sector or NCE which has lost contact with subordinate Nodes or TCEs.

Reporting Disturbance Detail--This display is for a single Sector or NCE. It lists each report which is overdue, and each subordinate site which is out of contact. Any communication system disturbance which could cause the failure to report is identified. See Figure 2-18.

CRITICAL SERVICE IMPACT SUMMARY

CONNECTIVITY PATH: DON–FEL

SEVERITY: 2 GROUPS

DEGREE: RED

QTY	RP	NETWORK	SERVICE
4	1	AUTOVON	1STs
8	2	AUTOVON	1STs
6	2	DEDICATED VOL.	
8	2	TTY	

ENTER NUMBER TO OBTAIN DISPLAY LISTED BELOW

[4] IMPACT LIST
[1] CONNECTIVITY PATH SUMMARY

Figure 2-17. Critical Service Impact Summary Display

REPORTING DISTURBANCE DETAIL

REPORTING DISTURBANCE DETAIL   STUTTGART SECTOR

STATUS	TYPE OF REPORT	NODE	TIME LAST RECEIVED	COMMENTS
OVERDUE	KEEP ALIVE	FELDBERG	0729	LINK OUT – REPORT 092

Figure 2-18. Reporting Disturbance Detail Display

Report Index--This is a list of all transmission system reports submitted to ACOC. The operator can call up any of these reports for any reporting station, link, trunk, or circuit. See Figure 2-19. When a specific report and station or link/trunk/circuit is selected, the operator must scan all of the reports of that category still resident in the computer system. Reports will be saved for the past 24 hours or until the disturbance has cleared, whichever is longer.

Report Detail--These displays allow the operator to review the selected report.

The following displays fall into the category of Network Resource inventory. This category of displays encompasses a variety of access techniques for the circuit, trunk and link data bases, and the Critical Restoral Plans. This data is used for selecting the reroute strategies and adding connectivity. Each display is described below.

Station Resource Summary--A listing of links terminating at a station, their destination, their status, and the availability of spare groups or circuits.

Link Detail--The source, destination and status of a specified link, the identification of the trunk using each group, and the quantity and identification number of spare circuits on each trunk.

Trunk Detail--The source, destination, and status of the specified trunk, the list of links on which it rides, and the list of circuits riding on it. The associated CCSD if it is a VFCT.

REPORT INDEX

1. SCHEDULED REPORTS
2. DAILY REPORTS
3. Q–LINE REPORTS
4. OUT–OF–SERVICE REPORTS

TO REVIEW REPORT ENTER NUMBER ____ STATION ID ______
LINK ID ______
TRUNK ID ______
CIRCUIT ID ______

Figure 2-19. Report Index Display

Circuit Detail--The source, destination, and status of the specified circuit, the list of trunks on which it rides and associated channel number. If it is a VFCT, includes the associated trunk number and list of subchannels.

Multiplex Diagrams--Graphical representation of interconnection of groups between links at a station.

Critical Restoral Plan--Critical Restoral Plan for a specified circuit, trunk, link or site.

Connectivity Resources--Listing of circuit segments identified by trunk number, channel number and interrupted CCSD which can be used to establish a connection between two specified sites. This function can be used by circuit engineering by including a specification that the connection may use only spare capabilities.

2.4 PERFORMANCE ASSESSMENT, STRESS DETECTION AND ISOLATION

Performance assessment, stress detection and stress isolation (PA/SD/I) is defined as the processing done on data from the DCS subsystems to provide the most usable information to the control functions. The algorithms used for performance assessment, stress detection and isolation are, therefore, defined by the types of displays required.

Real time performance assessment occurs continuously. It involves the collection and formatting of data to determine the quality of performance of the DCS. It includes monitoring 1) status indicators such as in frame synchronization/out of frame synchronization or switch operational/switch failed, and 2) continuously variable indicators such as received signal

level or traffic offered to a switch or trunk group.

Stress detection involves reporting that status indicators have changed states, or that continuously variable indicators have exceeded thresholds. The thresholds can be selected to indicate that a parameter is trending toward a problem ("amber" or "warning"), or that a problem exists ("red" or "alarm"). The function of stress detection is done within the subsystems in some cases. It will be augmented by ACOC level algorithms in other cases.

Stress isolation is required because some stress indicators can be caused by multiple stresses. This is analagous to fault isolation in ATEC.

Examples of stress isolation are:

- o Correlating an AUTOVON trunk outage report with the ATEC indicated status of the carrying transmission system to determine whether the AUTOVON problem is caused by the transmission system.
- o Correlating status reports for trunks between one particular switch and each other switch to determine if the particular switch is not communicating with any other switch; and is, therefore, isolated or out of service.

The following subsections discuss performance assessment, stress detection and isolation for:

- o Upgraded AUTOVON/AUTOSEVOCOM II

- AUTODIN II
- The Transmission Network (the DSCS and Terrestrial Transmission systems)

2.4.1 AUTOVON/AUTOSEVOCOM PA/SD/I

AUTOVON performance assessment is performed primarily at ACOC. Theatre is the lowest level in the hierarchy that has visibility of the entire network. It is the lowest level that can observe the effect of and determine appropriate response to network stress because the effects of stresses and control responses tend to diffuse throughout the network. Typical stresses detected and appropriate control responses are shown in Table 2-1.

The first stress shown, loss of access connectivity, is not supported by parameters sent to ACOC. However, it also does not impact the performance of the network as a whole and there is no action that could be taken from ACOC to respond to it. Restoration of access connectivity is primarily a local tech control function. Local alarms are sounded at the TTC-39 switch if access connectivity is lost, which will aid in the prompt resotral of the access circuit.

There are parameters supporting the detection of a loss of trunk connectivity. A message is issued by the TTC-39 whenever it finds that it is unable to use a trunk group. This report could be correlated with transmission system performance monitoring data at lower levels, but there are several factors which taken together suggest that this correlation should occur at area.

Table 2-1. System Stresses and Applicable Controls

STRESS	CONTROL	AFFECT
LOSS OF ACCESS CONNECTIVITY	RESTORE CONNECTIVITY	ASSURE CRITICAL SUBSCRIBER CONNECTIVITY
LOSS OF TRUNK CONNECTIVITY	RESTORE CONNECTIVITY OR ADD CONNECTIVITY AND CHANGE ROUTING	IMPROVE ROUTINE GOS IMPROVE ROUTINE GOS
SWITCH FAILURE	REHOME CRITICAL SUBSCRIBERS CHANGE ROUTING TABLES CALL INHIBIT FAILED SWITCH	ASSURE CRITICAL SUBSCRIBER CONNECTIVITY IMPROVE ROUTINE GOS IMPROVE ROUTINE GOS
GENERAL TRAFFIC OVERLOAD	ALTERNATE ROUTE CANCELLATION ADD CONNECTIVITY	IMPROVE ROUTINE GOS IMPROVE ROUTINE GOS
FOCUSED TRAFFIC OVERLOAD	CHANGE ROUTING TABLES (TO REMOVE TANDEM TRAFFIC) ADD CONNECTIVITY	IMPROVE ROUTINE GOS IMPROVE ROUTINE GOS

These factors are as follows:

1) There is a significant time lag between when the switch discovers it cannot use the trunk group and the time at which ATEC fault isolates a problem and determines that an AUTOVON trunk is impacted.

2) Whether or not a transmission problem is the cause of the trunk group failure, there is a trunk group failure in AUTOVON. It could be caused, for example, by the station wiring between the switch and the MDF. In this case, ATEC would never report a problem but the trunk group has failed nonetheless. The area control function therefore needs the TTC-39 report regardless of the actual status of the transmission system.

3) The trunk group failure report is ambiguous, in that the TTC-39 will report a trunk group failure in response to a transmission problem, or the failure of the distant end switch. It does this because the switch does not have sufficient visibility to tell the difference between these two events.

ACOC is the lowest level which can resolve the message ambiguity. It can do this quite easily be correlating the trunk group failure alarms from throughout the network. The algorithm required to perform this correlation is shown in Figure 2-20. If the transmission system has failed (in either

direction) the switches on each end of the trunk group will report a trunk failure. If both switches do report the failure, they will do it (almost) instantaneously, before ATEC has had a chance to fault isolate the problem. However, further confirmation of the fault can eventually be obtained from ATEC data in most cases so it is reasonable to wait for ATEC correlation before alarming the controller.

Another possibility which would cause the same message type to flow would be the complete failure of the distant end switch. In this case, the correlating data is a similar message from all of the switches which have trunks to the distant end switch, and an absence of normal message traffic from the distant end switch. The last possibility is that for some reason the distant end switch is still reporting traffic but not passing any traffic. Reasons for this would either be the failure of all of the switch's trunk groups or some pathological switch failure mode. These two cases can be separated by correlating with ATEC data.

Other equipment failures less drastic than complete switch failure would not prevent the switch from carrying traffic. However, the theatre level control function must be congnizant of any switch degradations to prevent overloading the degraded switch or creating vulnerabilities in responding to other network problems. For example, if the Martlesham Heath switch failed, a normal restoral strategy might rehome its critical subscribers to Hillingdon. But if Hillingdon had most of its digit receivers in a failed condition, the extra originating load caused by the users normally homed on Martlesham Heath

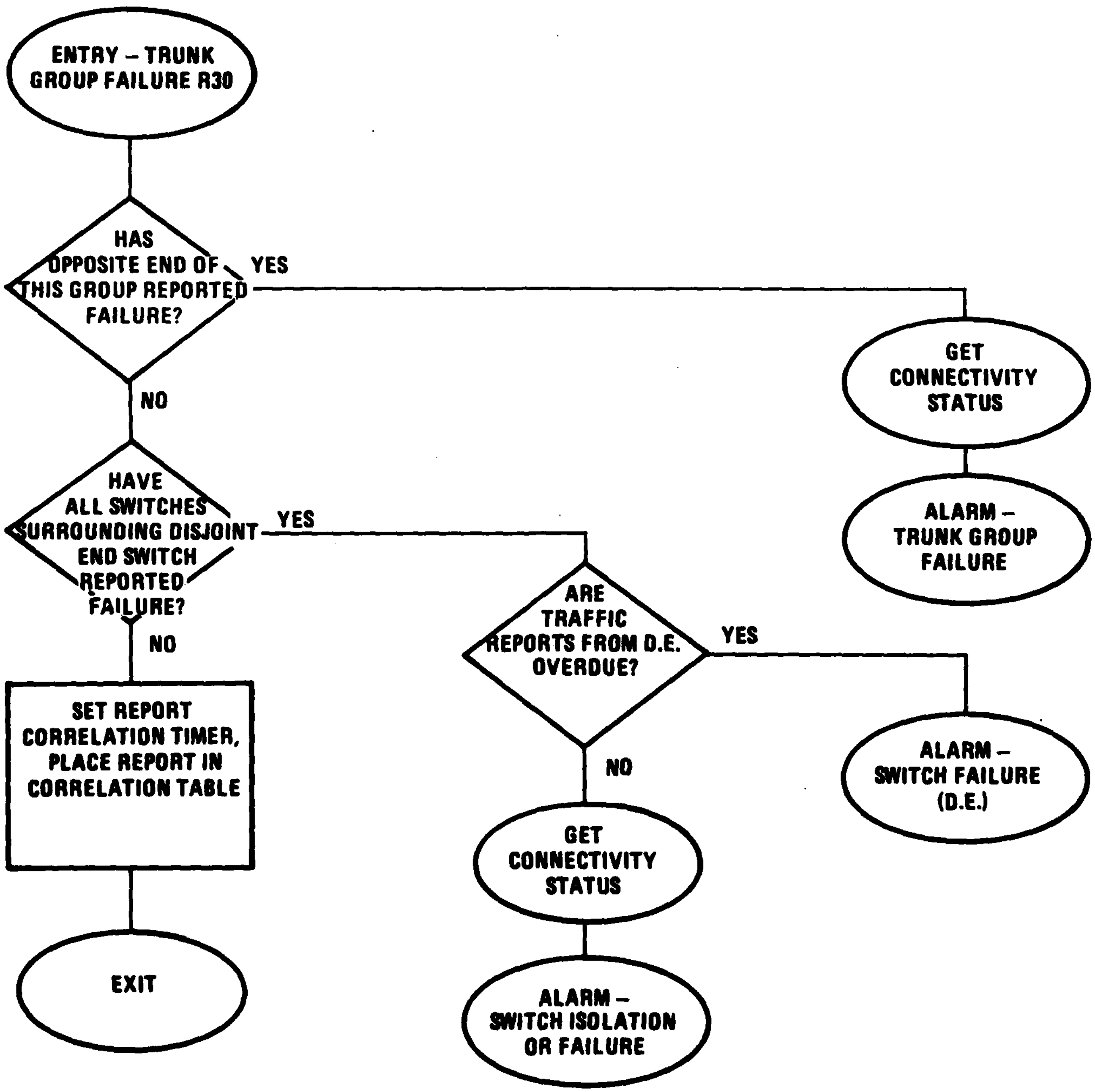


Figure 2-20. Trunk Group Failure Correlation Algorithm

could overload the remaining capacity at Hillingdon. In this case, a better response to the stress would be to rehome to Feldberg and Schoenfeld, even though this causes a large amount of transmission resource for access circuits.

Traffic overload refers to the situation where the demand for service exceeds the nominal busy hour demand due to some event independent of the network itself, such as a military crisis. If there is a traffic overload in one part of the network, the controller may wait to change the routing to shift traffic away from that part of the network. Certainly, the controller needs to be aware that some part of the network is heavily loaded so that control actions which shift traffic to that part of the network are avoided. If the entire network is overloaded, better overall service can be provided by restricting routine users to primary routing only. Because of these items, a means for determining the traffic status must be provided to the control function.

As shown in the parameter selection, call attempts and overflows on the trunk groups provides the appropriate data for determining traffic status. For the convenience of the controller, these parameters are converted to call congestion in two ways. The first measure of call congestion is the theoretical value computed from the Erlang B blocking formula. If the traffic is close to Poisson, this formula will closely predict the trunk blocking from the number of attempts. Because of the routing strategy of AUTOVON, the traffic is normally close to Poisson. Another measure of

call congestion is the observed value, which is the number of overflows divided by the number of attempts. Figure 2-21 illustrates the computation and use of these computed values. They are compared sequentially to two thresholds. If the lower threshold is exceeded, a warning flag in the status file is raised, but no alarm sounded. An alarm is issued if the upper threshold is crossed. These thresholds are not constants, but are related to equipment status. Any time a change in trunk or switch equipment is detected, as described previously, or when new busy hour traffic requirements are entered, a set of thresholds related to the expected call congestion on the trunks is computed as an output of the network performance prediction algorithm.

The network performance prediction (Figure 2-22) prevents traffic alarms from being issued in response to equipment status changes. If the performance of the network in normal traffic peaks will be unacceptable, network performance prediction will detect and alarm that. It then sets thresholds for the call congestion routine so that a duplicate alarm is avoided when the network performance degrades to its predicted value.

2.4.2 AUTODIN II PA/SD/I

PA/SD/I for AUTODIN II is handled within the planned Packet Switching Nodes (PSN's) and Network Control Center (NCC).

The PSN's in Europe will necessarily coordinate with the transmission system to isolate faults which exist between PSN's or on access lines. Of

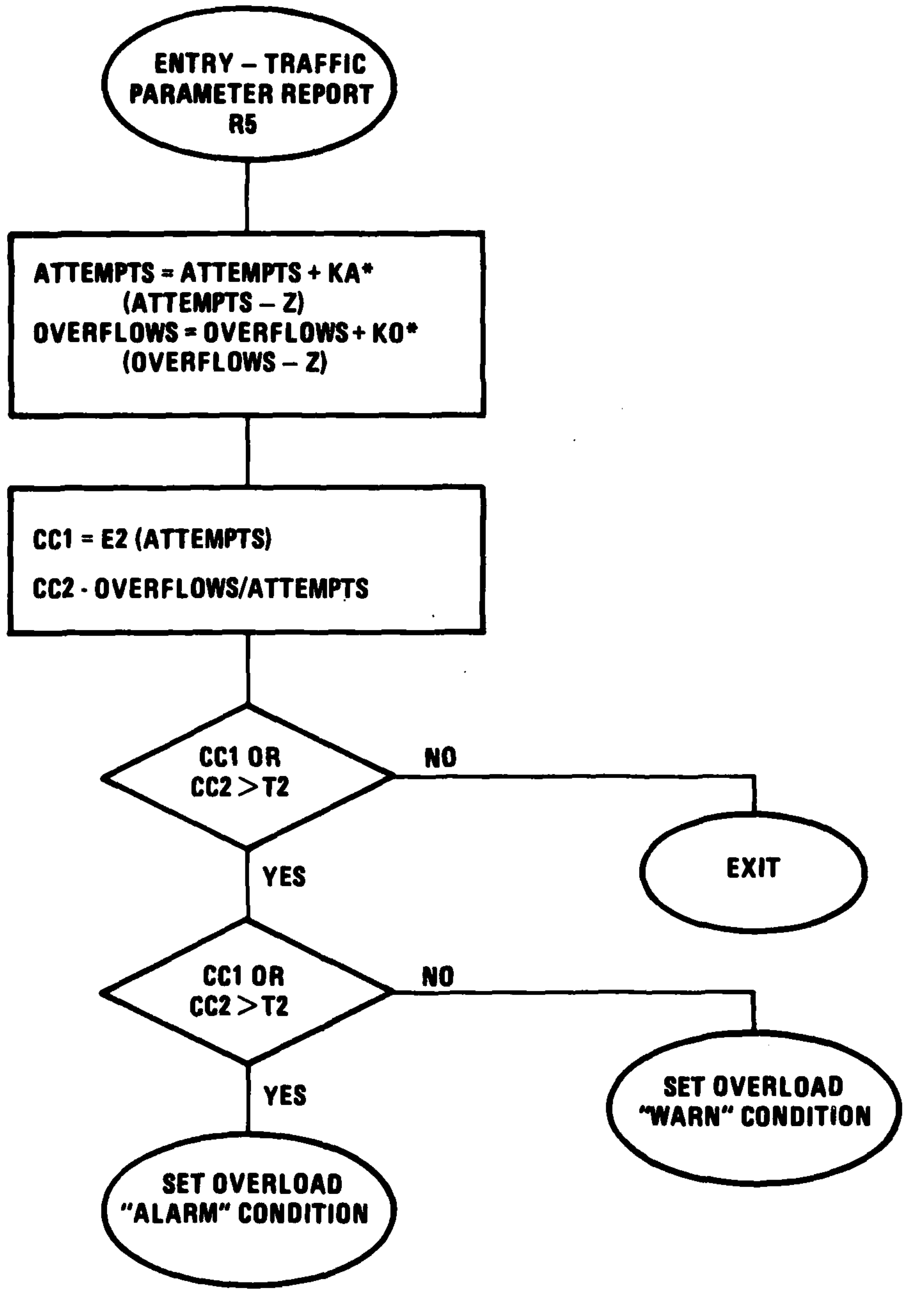


Figure 2-21. Traffic Thresholding Algorithm

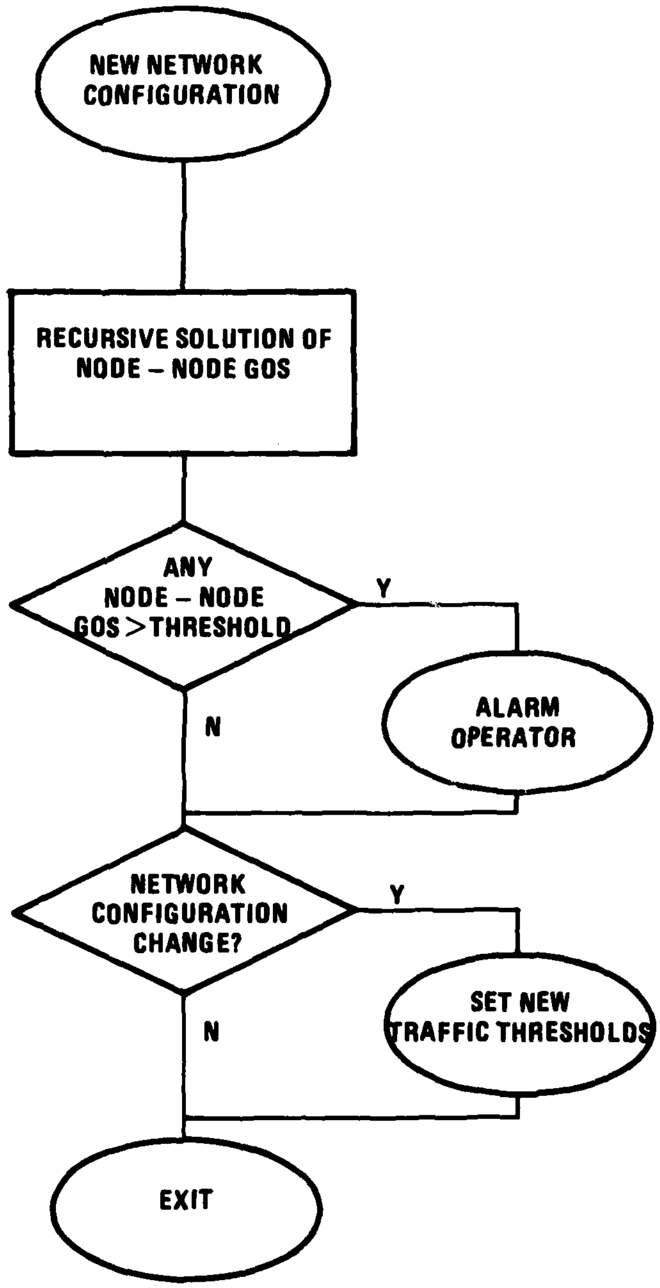


Figure 2-22. Performance Prediction Algorithm

consequence for Network wide control is the status of the interswitch trunks and high priority access lines as well as the offered traffic and any delays or backups. These data are sent to the NCC by each PSN. An extensive complement of displays to present the data is defined for NCC. See Reference 7.

Significant events are reported to DCAOC via 55-1 reports. The subjects reported are listed in Table 2-2. The recommended system will use an SNCC in Europe with the same capabilities as the NCC. This will report via 55-1s to ACOC. These are used to develop an overall European DCS status display supported by the real time System Control computer at ACOC. Faults in the transmission system which impact AUTODON II can be reported to the SNCC on the same telemetry path as the 55-1s use. At the discretion of the SNCC operator, this information can be passed to the PSN's.

2.4.3 Transmission Network PA/SD/I

The transmission network PA/SD/I will be supported by the Control Segment for the DSCS and by ATEC for the terrestrial transmission system. The transmission network PA/SD/I functions performed at ACOC are:

- Assessment of overall transmission network status
- Determining if a station is isolated or out of service

Assessment of overall transmission network status is supported by the parameters required from the transmission systems. Specifically, any station, link, trunk or critical circuit failures or degradations must be reported upon the completion of fault isolation. These data are formatted

TABLE 2-2. ITEMS REPORTED FROM AUTODIN II NCC TO WWOLS

Items which are trended: o Blockages recorded o Preemptions o Buffer utilization o Processing delays o Timeouts o Retransmissions
Items reported as a result of status changes: o PSN o Access line o IST o Critical Switch function -Switch buffering allocation -Source switch connection control -Source switch control for access denial -Destination switch timeout control -Switch directory table update -Switch outage and reload -Interlace detection

into the Network Connectivity displays discussed previously. These displays will be used to determine if a special response to a fault is required. The special response will be ACOC direction of restoral, taking into account the overall transmission network status.

The DSCS Control Segment specification defines the parameters to be monitored and calculated in the Control Segment. These parameters will in general be available on demand from the OCE which, in the recommended system, is integrated into the overall Network Control function at ACOC. An additional requirement to report changes in status of the station, link, trunk, or critical circuit has been imposed on the Control Segment. The equipment status defined in the Control Segment specification must be translated to the affected link, trunk, or circuit before reporting. In addition, fault isolation must be completed, to assure that only the highest level fault is reported. There is no requirement for this function in the available Control Segment specifications.

The ATEC 10000 specification requires monitoring the terrestrial transmission system to obtain the necessary link, trunk and circuit status. Fault isolation is required, so that only the highest level fault need be reported.

The recommended operation of ATEC is that a change in state of a link, trunk, or high priority circuit be reported to ACOC after fault isolation has been completed.

The data received from ATEC and the Control Segment will be used to determine if a site is totally isolated or out of service. An algorithm for this is shown in Figure 2-23. Note that the report must have the status as rem from both ends or in both directions of the link and the status of the telemetry to the end sites in order to compile this algorithm.

Additional algorithms necessary for the Transmission Network include the transmission fault correlator, shown in Figure 2-24. This includes a five minute delay if the first test proves negative because of the potential delay in ATEC completing fault isolation. It also includes a request of a Monitor Immediate of the circuit because if the fault was at circuit level, there could be a 15 minute delay until ATEC does an in-service test.

Finally Figure 2-25 illustrates the data base and display updating which will be done in response to an outage report.

2.5 SCENARIOS

The following scenarios demonstrate the response of the recommended System Control capabilities to system level stress. Selection methodology and a complete list of scenarios are contained in the first technical report. Further details of the scenarios are contained in Appendix C.

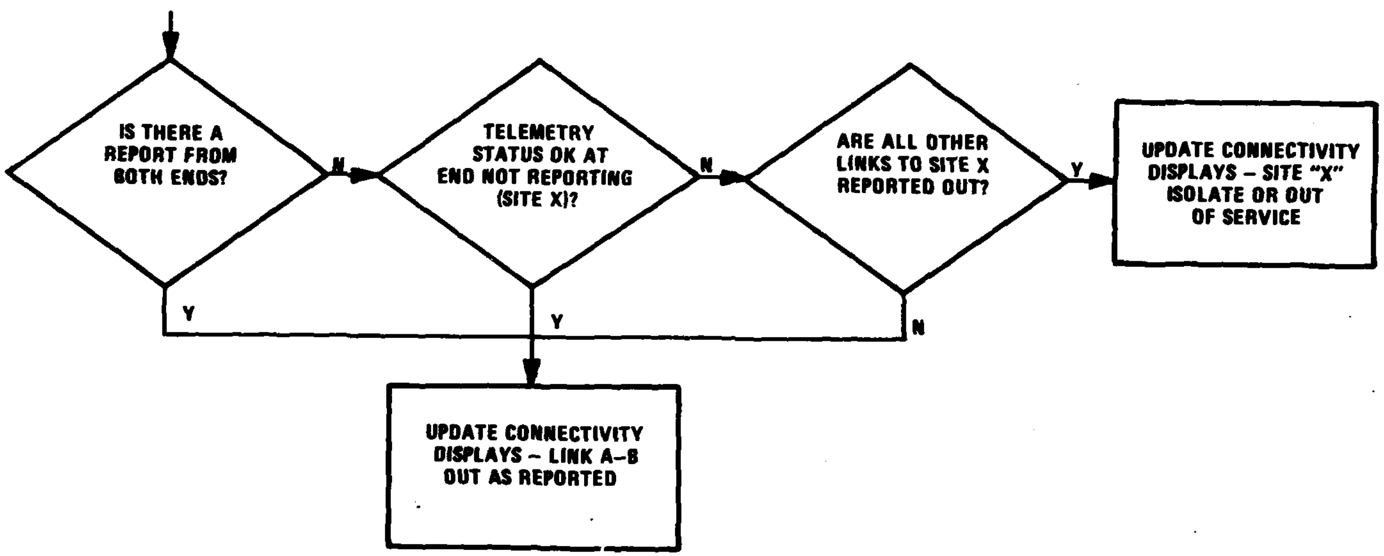


Figure 2-23. Station Isolation Algorithm

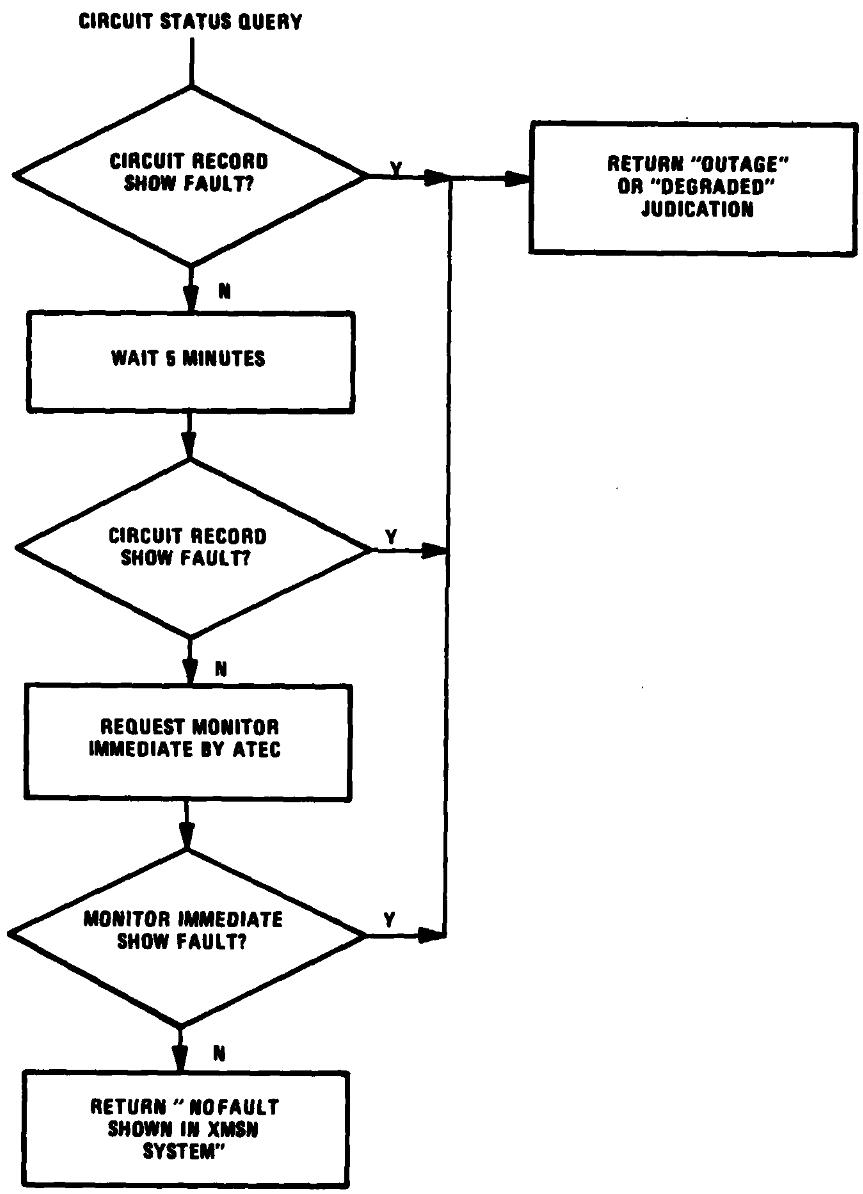


Figure 2-24. Transmission Network Fault Correlator

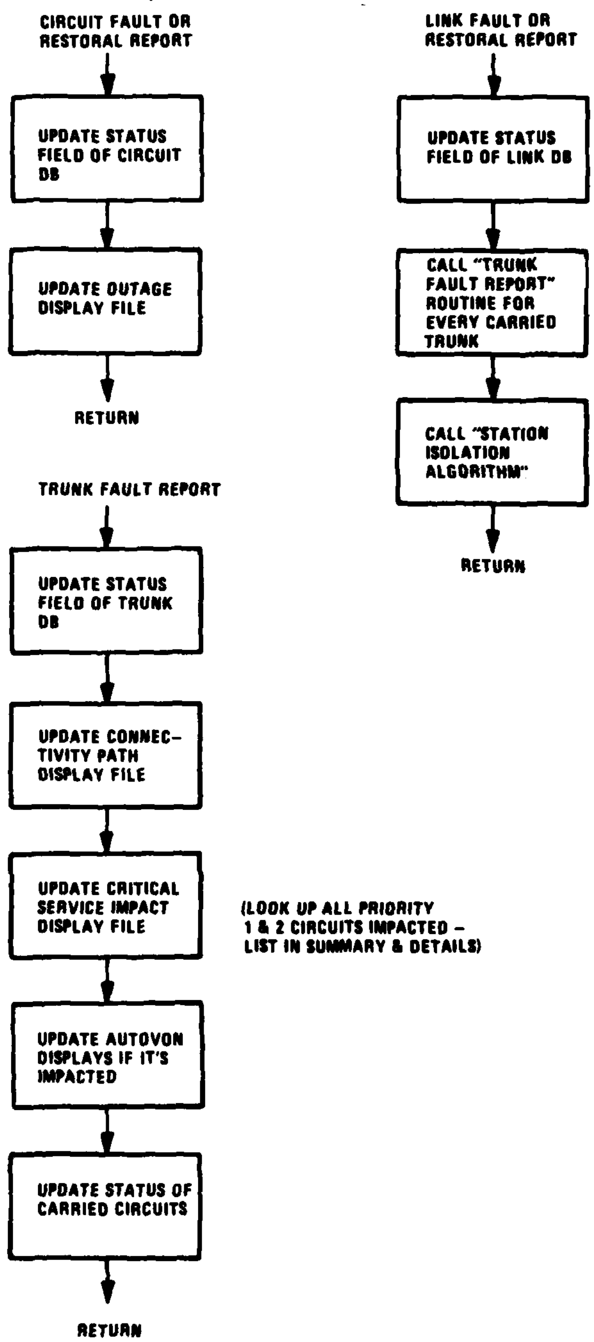


Figure 2-25. Data Base and Display Updating for the Transmission System

Node Outage (Scenario Two)--The DCS station at Feldberg is totally destroyed during normal peak busy hour. The equipment destroyed includes the TTC-39 switch, all RF and multiplex equipment, emergency power equipment, distribution frames, antennal and tower equipment. The events that occur following that destruction are as follows:

Event Time	Description
00:00:00.0	Feldberg station experiences complete failure.
00:00:00.1	All adjacent switches issue R30 messages indicating failure of the Feldberg trunk group.
00:00:00.2	Transmission system alarms are detected by the ATEC ARS elements. ATEC fault isolation begins.
00:00:02	Switch reports arrive at ACOC. Trunk fault correlation algorithm identifies the stress as a node failure at Feldberg, but no alarm is issued because traffic parameter reports are not overdue. The summary display, trunk status display, and trunk fault detail displays for each affected trunk group are updated to reflect the report arrivals.

Event Time	Description
00:02:00	ATEC fault isolation determines failure of all links to Feldberg whose monitoring stations report to a working node. Link failure messages are sent to ACOC from Stuttgart and Langerkopf sectors.
00:03:00	ATEC fault isolation terminates. ACOC determines that transmission failures have isolated the Feldberg station. Connectivity control is alarmed.
00:03:30	Traffic reports from Feldberg become overdue, completing the AUTOVON fault isolation routine. AUTOVON controller is alarmed that Feldberg has failed.
	Data base access finds the list of critical circuits interrupted and prepares display for connectivity controller.
00:03:45	AUTOVON controller directs the Donnersberg switch to take over DSCS circuits and become gateway. All routing tables are updated to reflect the new routing.
00:05:00	Local tech controllers at Pirmasens, Landstuhl, Berlin, and Bocksberg initiate pre-planned restoral actions to restore the 3 AUTODIN access circuits and the command and control circuit via DSCS.
	All AUTOVON switches are now operating with new routing.

00:10:00	AUTODIN access and command and control circuits are patched through DSCS.

The repairs necessary in this scenario are so extensive and gradual that return of the system to its nominal capacity is not part of the scenario.

Node Outage with Major System Control Telemetry Failure (Scenario 29)--The system stress in this scenario is identical to the previous scenario (Scenario Two), except that the sector-sector telemetry and the sector-area telemetry at Langerkopf also fails simultaneously. Without manual data transfer and correlation, ATEC is unable to fault isolate this scenario. The events which would occur are as follows:

Event Time	Description
00:00:00.0	Feldberg station experiences complete failure. Langerkopf sector has a failure of the communication line controller on the ATEC processor.
00:00:00.1	All adjacent switches issue R30 messages indicating failure of the Feldberg trunk group.
00:00:00.2	Transmission system alarms are detected by the ATEC ARS elements. ATEC fault isolation begins. ATEC telemetry alarms are detected at HIN and SGT.

Event Time	Description
00:00:02	Switch and ATEC telemetry alarm reports arrive at ACOC. Trunk fault correlation algorithm identifies the stress as a node failure at Feldberg, but no alarm is issued because traffic parameter reports are not overdue. The summary display, trunk status display, and trunk fault detail displays for each affected group are updated to reflect the report arrivals. Connectivity controller contacts Langerkopf sector on the order wire to obtain verbal status updates.
00:02:00	ATEC fault isloation determines failure of Link M0293. Link failure message is sent to ACOC from Stuttgart sector.
00:03:00	ATEC fault isolation terminates. Link M0293 is the only link failure reported to ACOC. Langerkopf verbally reports failures of links M0083 and M0891, and unisolated MUX framing alarm at Donnersberg.
00:03:30	Traffic reports from Feldberg become overdue, completing the AUTOVON fault isolation routine. AUTOVON controller is alarmed that Feldberg has failed.
00:03:45	AUTOVON controller directs the Donnersberg switch to take over DSCS circuits and become gateway. All routing tables are updated to reflect the new routing.

Event Time	Description
00:05:00	Area controller manually enters fault data from Langerkopf sector. This causes failure analysis algorithms to determine that Feldberg is isolated and initiates data base search for critical circuits.
00:08:00	Upon direction from the ACOC connectivity controller, local tech controllers at Pirmasens, Landstuhl, Berlin and Bocksberg initiate pre-planned restoral actions to restore the 3 AUTODIN access circuits and the command and control circuit via DSCS. All AUTOVON switches are now operating with new routing.
00:13:00	AUTODIN access and command and control circuits are patched through DSCS.

As with Scenario Two, the repairs necessary in this scenario are so extensive and gradual that return of the system to its nominal capacity is not part of the scenario.

AUTOVON Trunk Group Failure (Scenario Nine)--The RF link between Donnersberg and Rhein Main, Germany fails due to antenna malfunction, interrupting the most heavily loaded intra-European AUTOVON trunk group. The subject of the scenario is the AUTOVON trunk group, the link failure has other collateral stresses in addition to the trunk group stress. The events that occur when the link fails are as follows:

Event Time	Description
00:00:00.0	RF link from Donnersberg to Rhein Main fails.
00:00:00.1	Switches at Donnersberg and Feldberg issue trunk group failure reports.
00:00:02.0	ATEC alarm reports of loss of RSL and multiplex framing alarm at Rhein Main and Donnersberg arrive at Feldberg and Donnersberg nodes respectively.
00:00:03.1	Switch reports arrive at area. Trunk fault correlation algorithm makes a preliminary decision that there is a transmission fault and updates its displays to indicate that.
00:02:00	Langerkopf reports failure of Donnersberg-Rhein Main link to area, confirming the trunk fault correlation algorithm's preliminary decision. AUTOVON controller is alarmed.
00:02:30	Data base access to Donnersberg node reveals the C^2 and weather fax collateral stress, and requests Langerkopf sector to check on the availability of links in the pre-planned altroute.

Event Time	Description
00:03:00	Area determines routing table changes for Donnersberg, Feldberg, Schoenfeld, and Martlesham Heath switches, and issues system control messages to those switches via telemetry.
00:03:30	Donnersberg receives status of pre-planned altroute, and initiates patching. Donnersberg also sends patch coordination to Langerkopf.
00:03:35	Donnersberg sends patch instruction to Feldberg node via Stuttgart sector.
00:04:00	Donnersberg switch executes loop test to Rhein Main ULS, activating a local alarm at Donnersberg. Since restoral activity has not already been completed, alarm is ignored.
00:08:20	Real time traffic reports from Donnersberg and Feldberg indicating stress arrive at area. Since control action is already completed, no further action is taken.
00:10:00	Patching C^2 and weather fax is completed.
06:00:00	Link restored.
06:00:02	Donnersberg and Feldberg report restoral of trunk group to area.

Event Time	Description
06:01:00	Donnersberg notifies Langerkopf to return to normal configuration; Langerkopf notifies Feldberg via Stuttgart.
06:01:30	Area broadcasts message to Donnersberg, Feldberg, Schoenfeld, and Martlesham Heath to return to normal routing tables.

At this time, the stress situation is over and the network returned to normal operation.

Partial AUTOVON Trunk Group Failure (Scenario 10)--First level multiplex failures between Donnersberg and Feldberg interrupt 18 of the 30 analog IST's and all the digital IST's between Donnersberg and Feldberg at normal busy hour. This scenario demonstrates the difference between a complete trunk group failure as in Scenario Nine and a partial failure. This scenario as described assumes that the TTC-39 switch does not automatically attempt to use in band signalling when the common channel signalling fails. The TTC-39 hardware would support an automatic attempt to use in band signalling since all switch terminations are monitored by the scanners, and in band signalling receivers are terminated directly on the switch matrix. If the software were modified to provide automatic changeover to in band signalling, several of the detailed reactions of the system would be different from those described here. The events which occur following the multiplex failures are as follows:

Event Time	Description
00:00:00.0	Digroup 7 of the DON-RMN-FEL B mission bit stream fails, causing the loss of 18 of 30 analog and all 10 digital trunks between DON and FEL.
00:00:00.1	AUTOVON switches at FEL and DON issue R30 trunk group failure messages. These messages enter the ATEC system at their respective nodes.
00:00:00.2	ATEC ARS elements at FEL and DON detect multiplex loss of frame alarms on Digroup 7-B.
00:00:01.8	Switch reports arrive at ACOC. Trunk fault correlation algorithm tentatively identifies fault as a trunk group failure, seeks transmission system confirmation. Summary display, trunk status display, and trunk fault detail display are updated to reflect the message arrivals and preliminary fault identification.
00:02:03	ATEC fault isolation terminates without identifying the cause of the fault. The loss of frame alarms, still present, are reported to ACOC.
00:02:40	Connectivity control function determines that the loss of frame alarms correspond to part of the recently failed AUTOVON trunk group, but that part of the group is not affected.

Event Time	Description
00:02:41	AUTOVON fault correlation algorithm determines that the trunk group failure alarm would be caused by the confirmed circuit failure, but that a portion of the group is still usable. A trunk group modification directive D10 is issued to FEL and DON switches directing them to reconfigure the remaining trunks into a usable trunk group.
00:05:23	Switch supervisors at DON and FEL complete the trunk group reconfiguration and place the group on line. R30 messages from DON and FEL, indicating the new trunk group on line, are sent to ACOC.
00:10:00	FEL and DON maintenance determine that the multiplexer at FEL is the problem based on local alarms at both ends.
00:11:30	BITE functions executed in the FEL multiplex indicate a faulty circuit card.
01:25:00	A proper replacement card is finally located and installed, restoring the multiplex to service.
01:30:00	Testing verifies that Digroup 7-B is now operating properly. A restoral of service message is sent to ACOC.
01:32:30	AUTOVON control is notified that its circuits have been repaired.

Event Time	Description
01:33:00	AUTOVON control sends trunk group modification directives to DON and FEL directing them to return to the normal configuration.
01:34:00	Switch supervisors add the trunks from Digroup 7-B to the operating trunk group.
01:34:30	Switch supervisors cut over from separated signalling to unified signalling.
01:35:30	Switch supervisors pull the patches for the temporary analog signalling channel.

This completes the return of the system to normal operation.

General AUTOVON Traffic Overload (Scenario 16)--The AUTOVON network in Europe experiences a buildup of traffic due to military operations. The traffic builds uniformly to a level of 250% of normal peak busy hour. All elements of the DCS - links, switches, etc., are operating properly. The events which occur during this overload are as follows:

Event Time	Description
00:00:00	Network is at normal peak busy load.
0C:30:00	Military operations commence with command and control notifications. This raises the traffic level to 115%.

Event Time	Description
00:45:00	Full administrative and command and control operations drive the network to 150% loading. Several trunk groups pass their overload threshold, causing a traffic alarm at the AUTOVON controller's position.
00:46:00	AUTOVON controller directs all switches to go to primary routing only for traffic below FLASH precedence. This is mechanized via a text message to the switch supervisors.
01:00:00	Pyramiding of communications requirements subsequent to command and control operations push the network load to 250% of normal peak busy hour.
01:30:00	Increased military operations are in full execution. Communications requirements begin to return to normal. Network load is now 175% of peak busy hour.
01:45:00	Communications requirements are down to 120% of peak busy hour. AUTOVON controller directs a return to full alternate routing capability via a text message.
02:00:00	Network returns to normal. Traffic load is below normal busy hour and will remain there.

2.6 SUMMARY

This section has described the recommended approach to integrate the subsystems of the 1985 DCS to provide data supporting real time System Control at the theatre level.

The changes to equipment are summarized in Table 2-3 . New equipment required is summarized in Table 2-4. Section III discusses the tradeoffs made in recommending this system and additional details of the implementation.

TABLE 2-3 . CHANGES REQUIRED IN DCS SUBSYSTEMS

SUBSYSTEM	CHANGES	
	HARDWARE	SOFTWARE
TTC-39	None	Report ring around rosy, single trunk failure.
SB-3865	Add SYSCON port	Add SYSCON reporting.
DIN II SNCC	Copy of NCC	Forward reports to NCC.
DIN II PSN	None	Address reports to SNCC.
ATEC SCS	None	Recognize ACOC as a valid address; report via 55-1s on critical faults when isolation is completed.
ATEC NCS	None	Same as SCS.
ATEC CIS	None	Recognize ACOC as a valid address.
DSCS OCE	A part of WWOLS	Integrated into Network Connectivity Control functions.
DSCS NCE	None	Report by exception to ACOC, correlate equipment faults to service impacted, fault isolate.
DSCS TCE	None	Correlate equipment faults to service impacted, fault isolate, ATEC protocol.

TABLE 2-4. NEW EQUIPMENT REQUIRED

- SYSCON Channel Acquisition Unit - Intercepts SYSCON channels from TTC-39 Interswitch Trunks.
- TTC-39 Report Consolidation Processor - Accepts SYSCON channels from all TTC-39's, handles ICD-004 protocol, and extends the telemetry to ACOC.
- Additional WWOLS Processor - To collect, process, and display data required at ACOC level.

SECTION III

DESIGN RATIONALE

3.0 INTRODUCTION

This section discusses the design rationale for the recommended system described in Section II. The following subjects are discussed:

- o Subsystem interfaces including those to the TTC-39 and SB-3865, as well as telemetry of this data to ACOC, and that between the DSCS Terminal Control Processor (TCP) and ATEC.
- o The analysis of the adequacy of ATEC to handle additional telemetry requirements.
- o The integration of the DSCS OCE function into the Network Connectivity Control function at ACOC, and the communication path between the NCE and OCE/ACOC.
- o The recommendation of using a AUTODIN II subnetwork Control Center (SNCC) in Europe and how this will work.
- o The data bases required at ACOC to support the recommended system.

3.1 SUBSYSTEM INTERFACES

This section discusses the methods of acquiring and telemetering data from the DCS subsystems. Referring to Figure 3-1, the information flow diagram, the new interfaces which must be established are:

9), TTC-39 to ACOC

10), SB-3865 to ATEC Communications Interface Set (CIS)

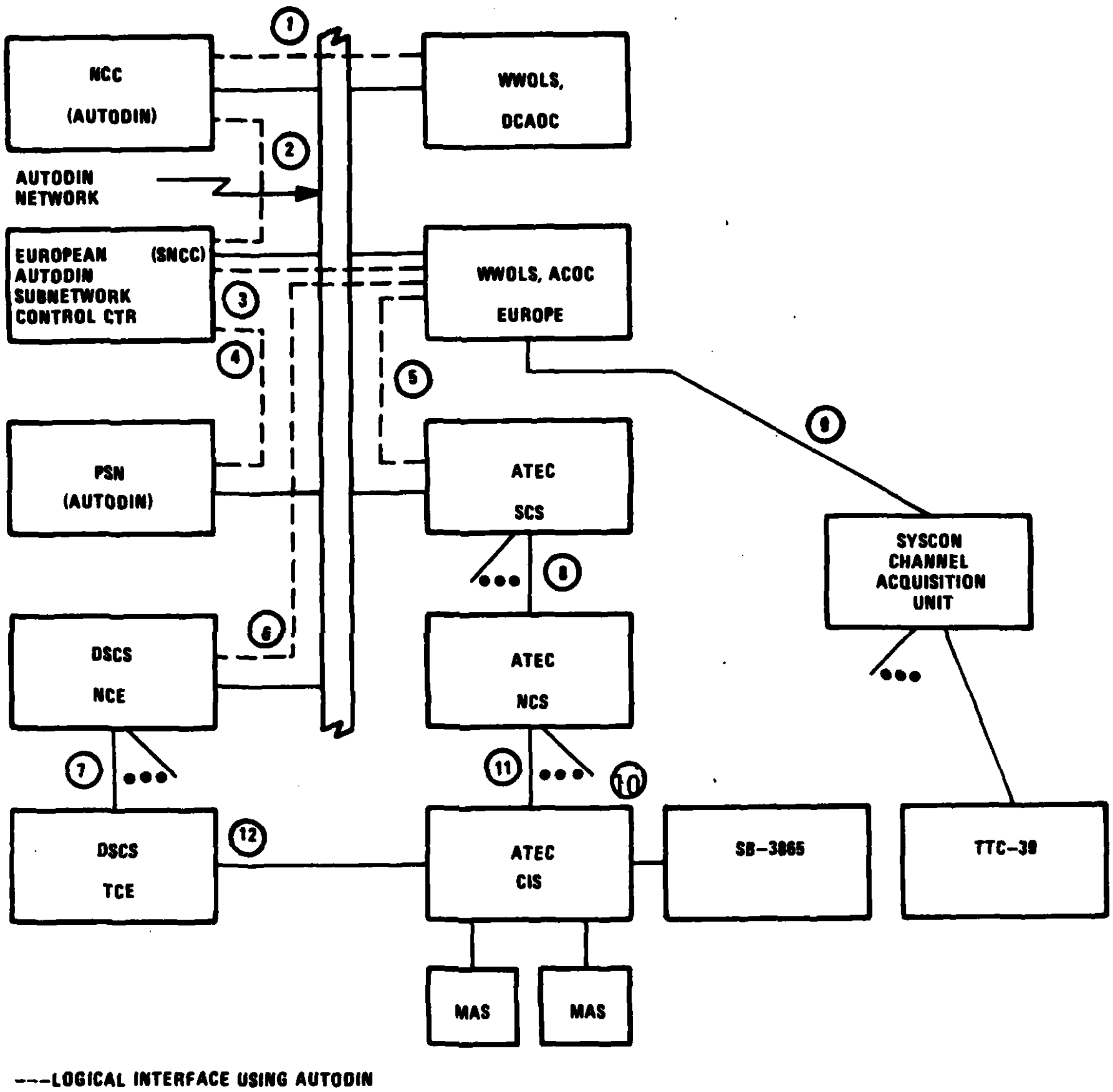


Figure 3-1. Subsystem Interfaces

12), Terminal Control Processor (TCP) to CIS

All of the other interfaces are already planned for the equipment involved.

The guidelines followed in selecting an implementation for the subsystem interface were:

- o Minimize changes to equipment
- o Select the simplest approach, e.g., the one with the least added equipment or one using existing capabilities
- o All else being equal, select the most fault tolerant approach

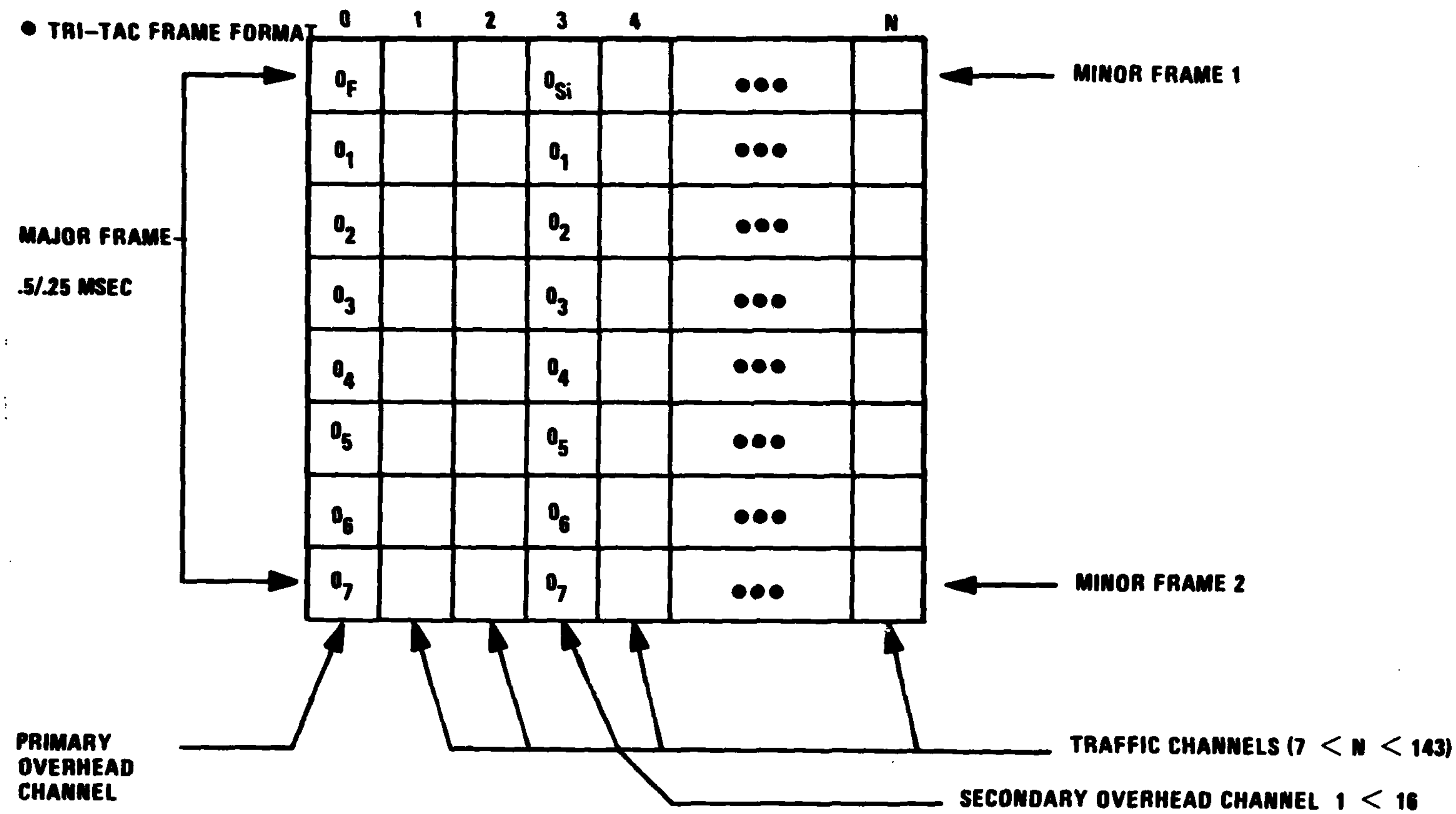
The alternatives considered and the reasons for selecting the recommended approach are discussed in the following paragraphs.

3.1.1 TTC-39 SYSCON Channel Acquisition

As designed for use in TRI-TAC, the TTC-39 multiplexes the SYSCON channel into the primary overhead channel of a TRI-TAC transmission group. See Figure 3-2. In TRI-TAC, the multiplex group would enter a communications Network Control Element (NCE) where it could pass through the Channel Reconfiguration Function (CRF). The CRF would permit the dropping and inserting of any subchannel so that it could be routed to a processor. However, in the DCS there is no equipment currently available which will drop or insert the subchannel.

The possibilities available for the DCS include:

a) modifying the TTC-39 to provide a new I/O port for the purpose of transmitting reports and receiving directions.



1. N BITS/MINOR FRAME X 8 MINOR FRAMES/MAJOR FRAME = 8 X N BITS/MAJOR FRAME
2. 0_F PATTERN 101010 ●●●
3. 0_S PATTERN 110011 ●●●
4. DOES NOT INCLUDE TYPE 2 FORMAT

Figure 3-2. Formatting of a TRI-TAC Digital Transmission Group

b) Employing a technique similar to that in TRI-TAC.

If method (a) is used, two options are available to implement data flow to and from ACOC. The first is to use a direct connection (dedicated circuit) from each switch to ACOC. The second option is to interface the TTC-39 SYSCON channel output to the collocated ATEC subsystem and route the data through the ATEC telemetry to ACOC. ATEC offers two possible interfaces: to the CIS through a 150 baud asynchronous port or to a collocated ATEC NCS using one of the SYSCON channels available at the Node processor (2400 baud).

If method (b) is selected, the routing options for getting the SYSCON data to and from ACOC are similar. If the SYSCON channel is extracted at the station where the TTC-39 is located, then either a direct circuit or interface with the ATEC subsystems can be considered. One additional option presents itself in this method: select a centralized switch to which all of the SYSCON channels can be routed using the inherent capabilities available in the TTC-39 for SYSCON channel routing. In this latter method, the SYSCON channels would be accessed external to the TTC-39's, all at a single site, routed to a single data concentrator and then forwarded to ACOC on a single channel or thorugh the ATEC telemetry.

The following two subsections examine the alternatives in the areas of channel acquisition and channel routing respectively.

SYSCON Channel Acquisition

The most straight forward, seemingly less complex, method of channel

acquisition is to modify the TTC-39 to provide a SYSCON channel I/O port. This can be accomplished by using the existing hardware in the TTC-39. The modifications would be in the area of the SYSCON Signalling Buffer where its output would be directed to a new I/O port rather than to the Trunk Signalling Buffer. Since the SYSCON Signalling Buffer is a microprocessor based device including Memory, I/O Interface, and Central Processor Group (CPG) Interface, the hardware in place can be used to accomplish the modifications without new hardware development and purchases. In addition to routing the output to a new I/O port, the microprocessor software can be modified to accommodate any line protocol and the I/O interface (which consists of a universal synchronous/asynchronous receiver transmitter (USART), timing and control) can be modified to provide a new output data rate if one different thatn 2Kbps is desired.

The method of extracting the SYSCON channel external to the TTC-39 could be performed by a Channel Reconfiguration Unit (CRU). This unit will perform the same function as the CRF does for both TRI-TAC and T1 channels. Feasibility demonstration models will be developed under an RADC contract. (See Reference 27)

This unit performs not only the SYSCON channel drop and insert function (for a number of groups) but also the function of reassigning traffic channels between a number of groups. This added capability is used to speed service restoral in the event of outages. When the CRU is deployed in the DCS, the SYSCON channel breakout will be available.

If the interface is required before the CRM is deployed, one possibility is

to develop a unit which performs only the drop and insert function on individual interswitch trunks. Figure 3-3 illustrates the functional components required.

The recommended approach to obtaining the TTC-39 SYSCON channel is to extract the SYSCON channel external to the TTC-39. This recommendation is made primarily due to the impact of requiring a change to a system already under development and near completion.

SYSCON Channel Routing

Four alternatives exist for routing the SYSCON channels to ACOC. They are summarized in Table 3-1. The first alternative is routing of the SYSCON channels from each switch to ACOC, depicted by Figure 3-4. The figure shows a SYSCON channel acquisition unit, a data rate conversion interface unit, a modem or TDM interface at each switch, a dedicated circuit to ACOC and a corresponding modem or TDM interface and ACOC communication interface hardware and software. Format conversion is integrated into the ACOC processor and therefore none is called out in Table 3-1.

Figure 3-5 shows the second alternative where the extracted SYSCON channel is interfaced with collocated ATEC subsystems. The figure shown a SYSCON Channel Acquisition Unit and data rate and format conversion unit at each TTC-39. The ICD-004 protocol/format is converted to ATEC compatible format and protocol. Data rates would be converted to 150 baud asynchronous for interface to the CIS and to 2400 baud synchronous to the NCS system port. In this case, each node routes the data to its sector, and from there to ACOC.

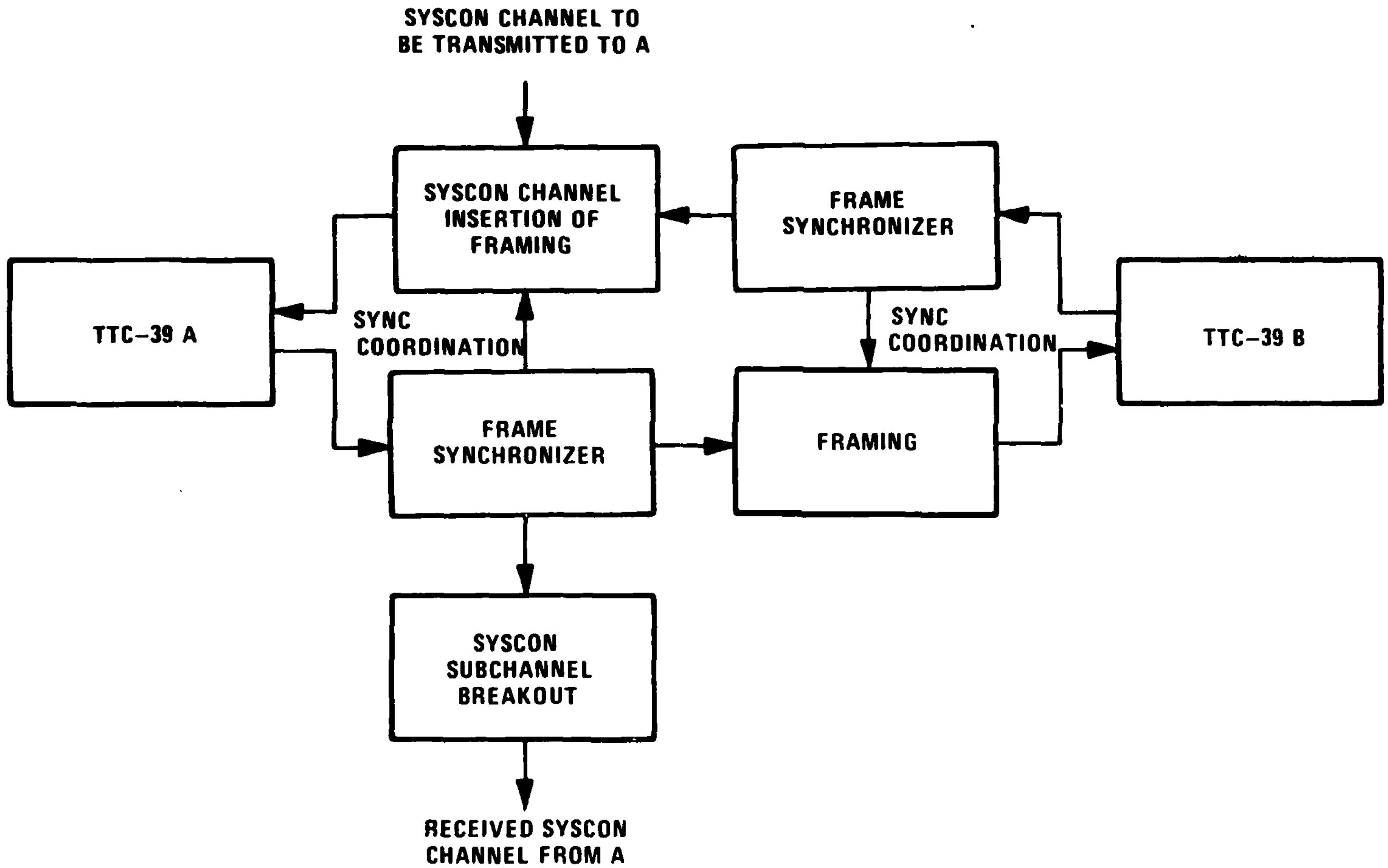


Figure 3-3. Components to Acquire a SYSCON Channel

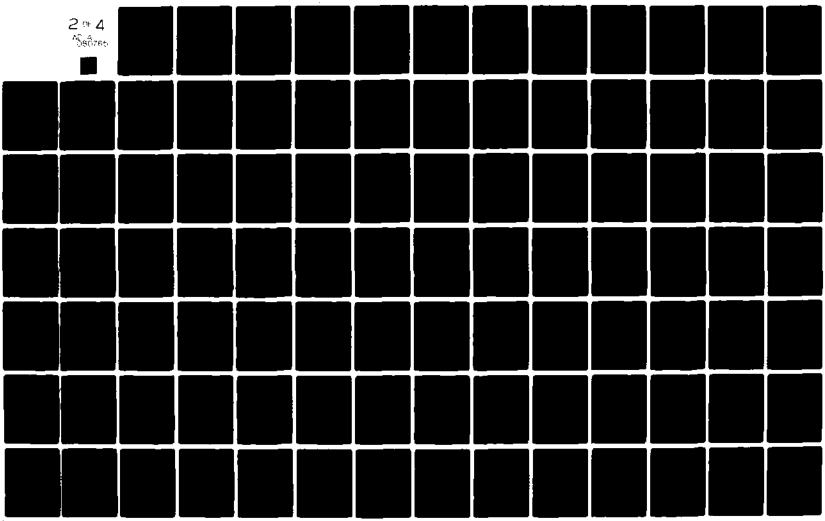
TABLE 3-1. CHARACTERISTICS OF ALTERNATIVE SYSCON CHANNEL ROUTING

TTC-39/ ACOC INTERFACE	SYSCON Channel Aquisition Units	Data Rate Converters	Format Converters	Communication Circuits	Modems or TDM Input Cards	Comm Line Interface at Receiving Processor
1) Direct reporting on dedicated circuit.	9	9	0	9	18	9
2) Reporting through collocated node.	9	9	9	0	0	0*
3) Using SYSCON channels to concentrate at central site, report on ded. circuit.	9	1	1	1	2	1 ACOC
4) Using SYSCON channels to concentrate at central site, report through ATEC.	9	1	1	1	2	1

*Uses SYSCON ports of the ATEC equipment.

AD-A080 765 HONEYWELL SYSTEMS AND RESEARCH CENTER MINNEAPOLIS MN F/G 17/2
SYSTEM CONTROL FOR THE TRANSITIONAL DCS.(U)
DEC 78 F C ANNAND, M F BURKE, R K CROWE DCA100-78-C-0017
UNCLASSIFIED TR-2 SBIE-AD-E100 326 NL

2 OF 4
AD A
080765



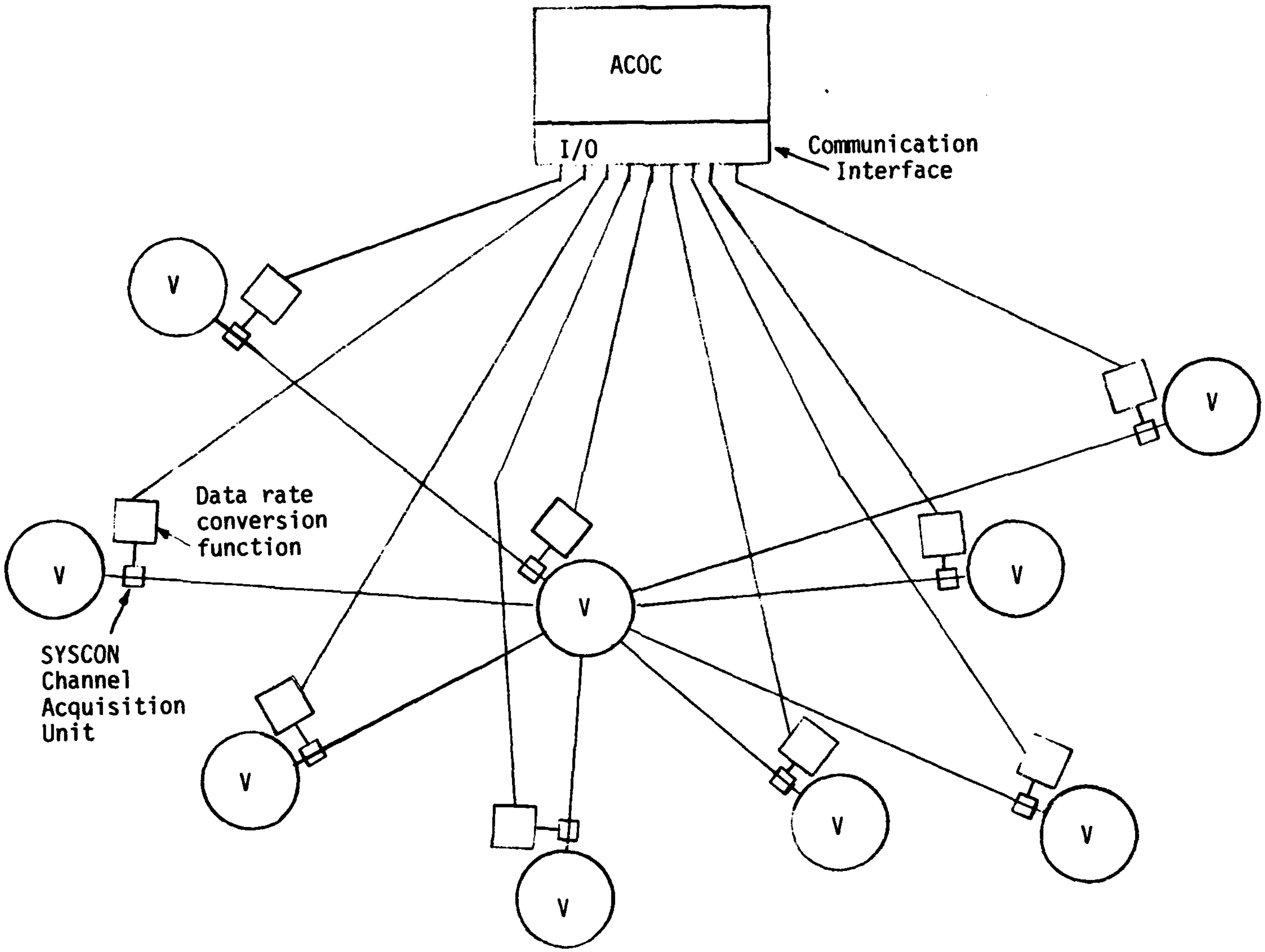


Figure 3-4. TTC-39 SYSCON Channel Direct Interface to ACOC

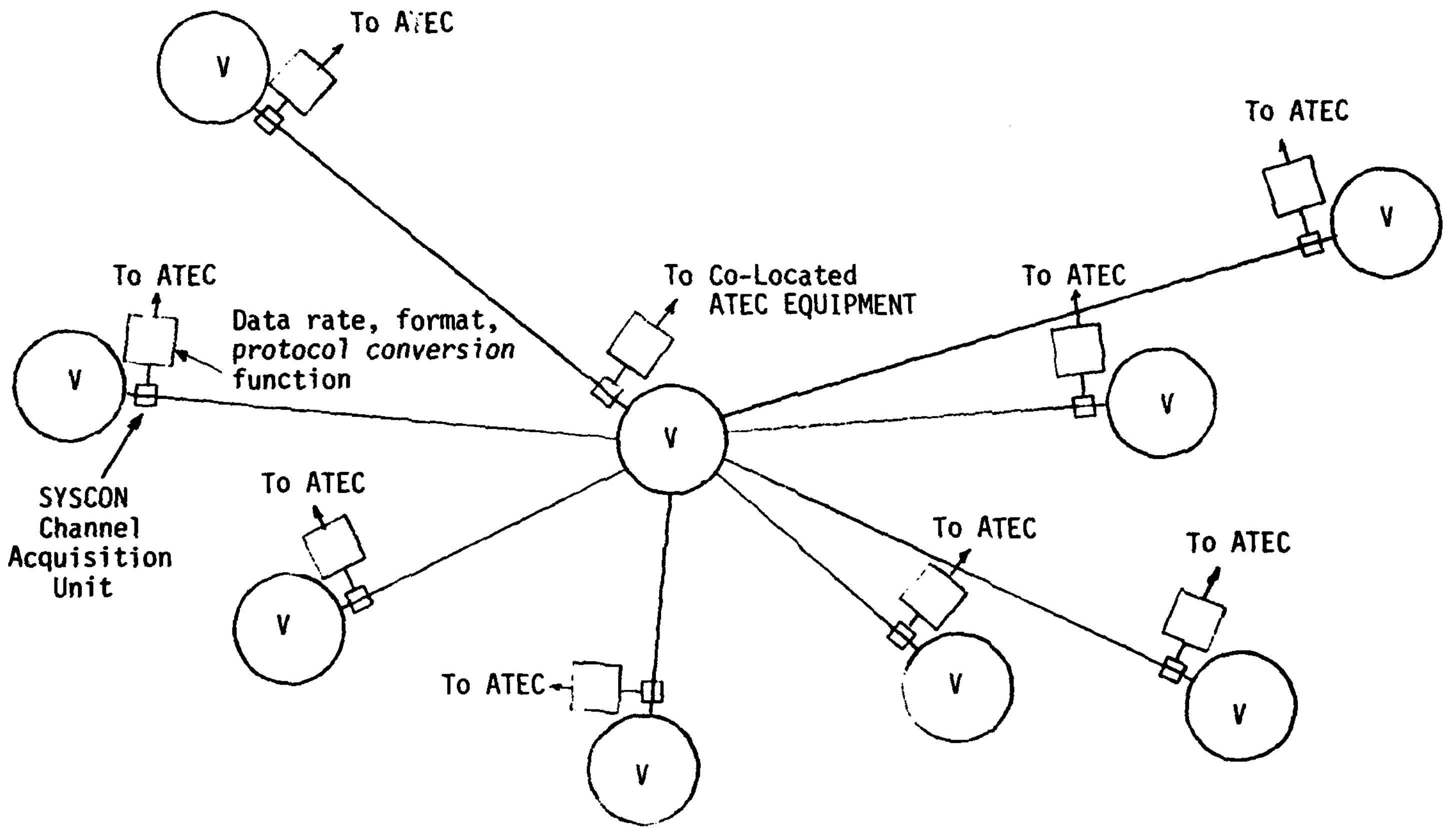


Figure 3-5. TTC-39 SYSCON Channel Interface Through ATEC

Figure 3-6 shows the third and fourth alternatives where all TTC-39 SYSCON channels appear at a single TTC-39 site. This alternative takes advantage of the capabilities to route the SYSCON channel through an intermediate TTC-39 if all TTC-39's do not have a DTG homed on the selected TTC-39 site. As the figure shows, all SYSCON channels acquired at the one site are combined through a single computer based data concentrator for transmission on a single circuit to ACOC. This single channel can be routed through a dedicated circuit (alternative three) or through ATEC (alternative four). A single 2400 bps channel is capable of handling even the worst case reporting load from all nine TTC-39's, since the average load from each switch is less than the 10 bps. However, if alternative four is used, a dedicated SYSCON port between the Sector and ACOC must be used, since the load cannot be handled by the AUTODIN interface to ACOC.

Table 3-1 shows that alternatives three and four require the least additional equipment. Alternative four introduces the data into the ATEC system, which would permit correlation of AUTODIN alarms plate to the transmission system and the ATEC indicated status of the transmission system. Section 2.3 discussed reasons why this was not recommended.

From an implementation viewpoint, the fact that one alternative would route the data into the ATEC system suggested re-evaluating the use of ATEC to correlate the data. The negative aspect of doing this is that most of the data routed to ACOC is not of interest to ATEC. Therefore, ATEC would process many messages not intended for it in order to identify whether or not it was interested. Even the data which ATEC is interested in will

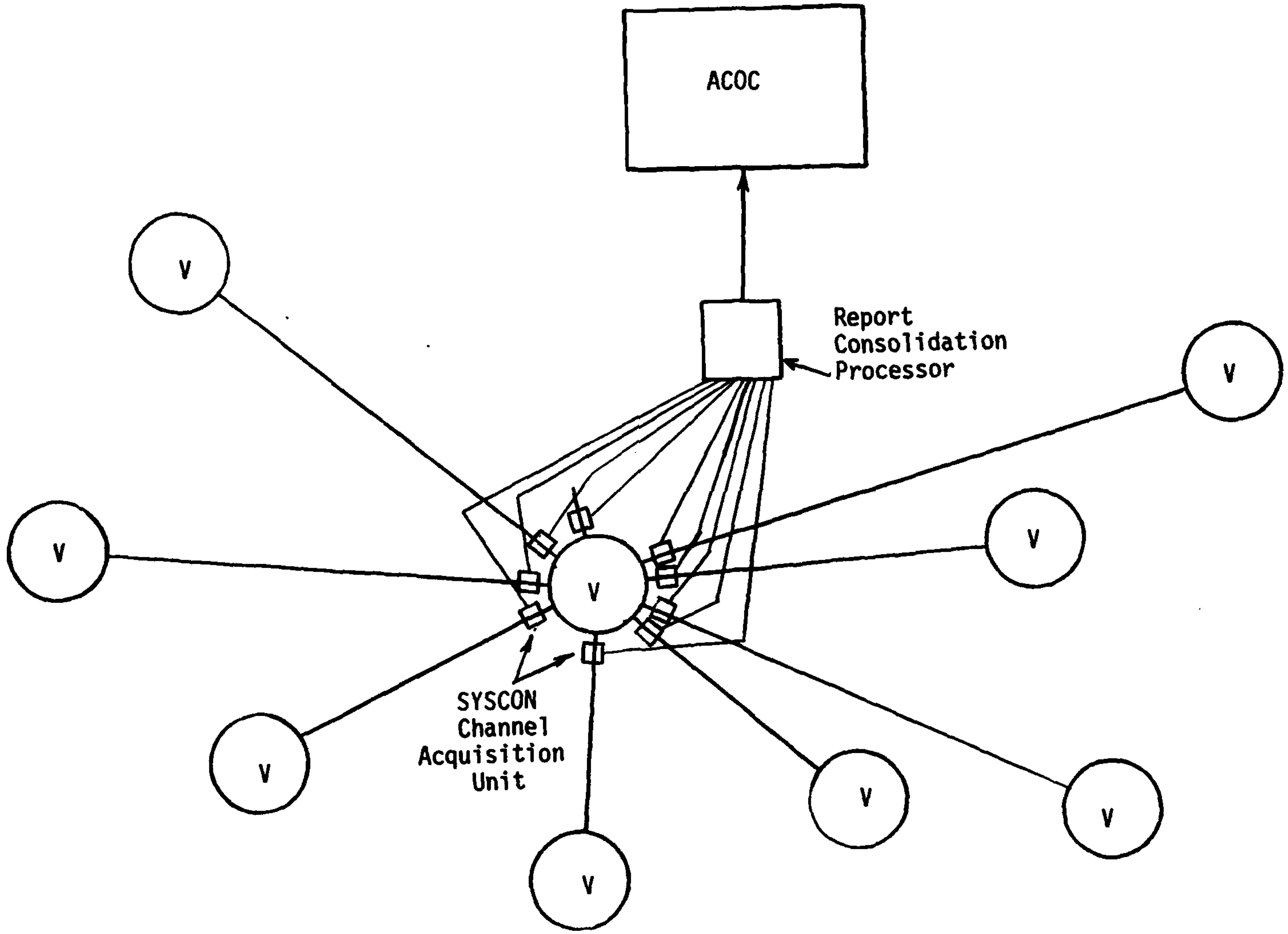


Figure 3-6. TTC-39 SYSCON Channels Routed to Central Location

ultimately have to be sent to ACOC because complete status of the AUTOVON system at ACOC is required. At ACOC, sufficient data for correlation of AUTOVON alarms to transmission system alarms will be available. This is true because correlation is done only when a trunk group is reported out of service, and in that case a high priority circuit will have been impacted and therefore reported by ATEC upon detection of the outage. Thus, the extra expense in adding a correlation in ATEC is of minimal value. To actually route the data into ATEC, and then immediately out again over the SYSCON channel is not a reasonable approach since it causes an added load on ATEC with no benefit. Performing the report consolidation process in the ATEC computer system was judged to be too much additional function to place on that computer. Therefore, alternative three is the recommended approach.

The added Report Consolidation Processor (RCP) must satisfy the interface protocols of the TTC-39 SYSCON channels (as specified by ICD-004). In order to minimize the bit rate to ACOC, the RCP will remove the idle characters from the SYSCON channels. It will then forward the data to ACOC. It will also accept data from ACOC and pass it down to the addressed TTC-39. The protocol selection for the 2400 bps synchronous interface to ACOC is discussed in the next section.

Recommended Protocol--The line protocol for dedicated synchronous lines may be either bit or byte oriented, since this is a processor-to-processor path, rather than a terminal to processor path. The candidate protocols considered were the ATEC protocol (byte oriented) or the ADCCP (Advanced

Data Communications Control Procedures), ANSI X3534/589, which is planned for use in both AUTODIN II and the DSCS Control Segment.

ADCCP has achieved acceptance by the United States government and the International Standard Organization (ISO) in addition to the American National Standards Institute.

Commercial equipment supporting this protocol has been and will continue to be developed. ADCCP is ideally suited to passing ICD-004 messages. This is a result of the transparency provided by the bit oriented message field. Because of its commonality and commercial acceptance, it is the recommended protocol for the RCP/ACOC interface.

3.1.2 SB-3865 Interface

The SB-3865 is not currently planned to have an interface for remote reporting of status data. It is planned to present the data to the attendant/operator via status and alarm displays and the attendant interface device. There are two areas of alternatives to consider in order to provide remote reporting capabilities:

1. The formatting of the report.
2. How to telemeter the report.

From some points of view, the most desirable method for formatting of the report is to use the formats of ICD-004 (reference 15). This will permit the same message analysis of software to be used at ACOC for both TTC-39 and SB-3865 messages. An additional commonality could occur in the software used to handle SYSCON channel protocols. This occurs at the computer

at Langerkopf for the TTC-39's. However, the use of the CIS's as the entry points for the SB-3865 data, discussed in the next section, requires handling the protocol at the SB-3865/CIS interface. Thus, the processor for the TTC-39's cannot be reused for the SB-3865's.

Another alternative is to use a reporting protocol for the messages from the SB-3865 different than ICD-004. If the information required could be limited to a sufficiently small amount, this would be a useful method. For example, if only the status parameters were reported, this could be used. In fact, direct acquisition of the status by connecting the status/alarm indicators into an ATEC Alarm Reporting Subsystem could be employed. To remotely report all of the data already collected by the SB-3865, the full ICD-004 messages are preferable.

The methods of telemetry for SB-3865 data considered include:

- Dedicated channel directly to ACOC.
- Use of subchannel to telemeter data to a TTC-39, at which point the data will be entered into the ATEC system.
- Telemetering data directly into an ATEC node via a dedicated channel.
- Entering data into an ATEC CIS port.

Use of the CIS port was selected. Discussion of these methods follows.

The use of a dedicated channel to ACOC for each SB-3865 was rejected on several bases. First, there will be some 50 SB-3865's in Europe. Therefore, an excessive number of circuits would be required. In addition, the data

flow would be relatively bursty, the long term average rate being about 9 bps. Therefore, a message switching arrangement offers advantages. Finally, having some 50 interfaces at ACOC is unwieldy.

The use of the subchannels to the TTC-39 is not supported by current configurations of the TTC-39 or the SB-3865. The TTC-39 does not expect to receive subchannels from access trunks, which is the method used to interface the SB-3865 to the TTC-39. Instead, in band signalling is used. If the TTC-39 were modified to accept such channels, a large number of them would need to be interfaced; up to 30 at Donnersberg, if all of the SB-3865's homed there were accepted. These would then be aggregated together into a single group to send to ACOC. However, the TTC-39 has no capability to multiplex this large number of subchannels together. For these reasons, the interface should not be made to the TTC-39.

The use of the Node as an entry point requires a number of SYSCON interfaces at the node possibly greater than defined by the ATEC 10000 specification. A total of three SYSCON ports and seven spare ports are required. Certain central Germany nodes could have more than that number of SB-3865's. Also, a DCS circuit from the SB-3865 site to the Nodal site would be required.

The alternative of sending the data into a CIS is attractive because it is expected that a CIS will be at the SB-3865 site. Because the CIS has 150 bps ports available, it would be desirable to use this rate as an output from the SB-3865. Since the SB-3865 must be modified to send or receive data, the requirement to do so at 150 bps can be added. Since the long term average rate, as discussed in the parameter analysis section, is about

9 bps, this would be a satisfactory rate.

The selected approach is, then, to use a CIS port for accepting data from (and eventually sending data to) the SB-3865. The selected approach is to modify the SB-3865 to provide a direct interface at 150 bps. To retain commonality with the TTC-42, ICD-004 formatted messages will be used. The alternatives of requiring the SB-3865 to fit the message into ATEC format or using an external unit were considered. The external unit was selected to minimize impact on the SB-3865.

The conversion from the ICD-004 format to ATEC message format is complicated by the use of an ASCII character oriented protocol in ATEC (seven bits plus parity). ICD-004 messages, on the other hand, use eight bits plus parity, and free form within the eight bits. Because no processing of the TTC-39 data is planned below ACOC, it is intended that the ICD-004 message format be retained between ACOC and the TTC-39. The approach to accommodate this is to define an ATEC message type which passes the ICD-004 formatted message within the ATEC message field.

In order to pass the non-ASCII characters through the message field, two approaches have been identified. The first is to pack six bits of the ICD-004 message into each ASCII character. The seventh bit will always be a one, so that no control characters will be generated by the reformatting. This allows the messages to flow through without special processing in ATEC. There will always be 216 bits in the ICD-004 message, requiring $216 \div 6 = 36$ characters.

Alternatively, processing of parity and control characters could be inhibited in the message field, and the 216 bits could be sent as a consecutive string in $216 \div 8 = 27$ characters. However, this requires special handling via establishing a message type telling software to ignore parity and control characters. Therefore, the first method discussed was selected. Figure 3-7 summarizes the recommended approach.

3.1.3 TCP/CIS Interface

The TCP is not completely specified at this time. The developers of the Control Segment anticipated that a 150 bps Port will be connected to the terrestrial DCS to permit reporting of status and coordination. It is recommended that this be connected into the ATEC computer system at a CIS port. This port was selected because, a) The 150 bps rate of the CIS port is consistent with the TCP plans, and b) It is expected that there will typically be an MAS system including ACIS at the DCS station where the satellite and terrestrial system interface, minimizing the 150 bps circuit to an intra-building connection in most instances.

Since the ATEC equipment will be developed ahead of the TCP, it is recommended that the TCP be specified for compatibility at this interface. The interface specification for ATEC is a byte oriented protocol defined for the ATEC application. The message formats are shown in Figure 3-8 and the transmit and receive protocols specified by the ATEC 10000 specification are shown in Figures 3-9 and 3-10.

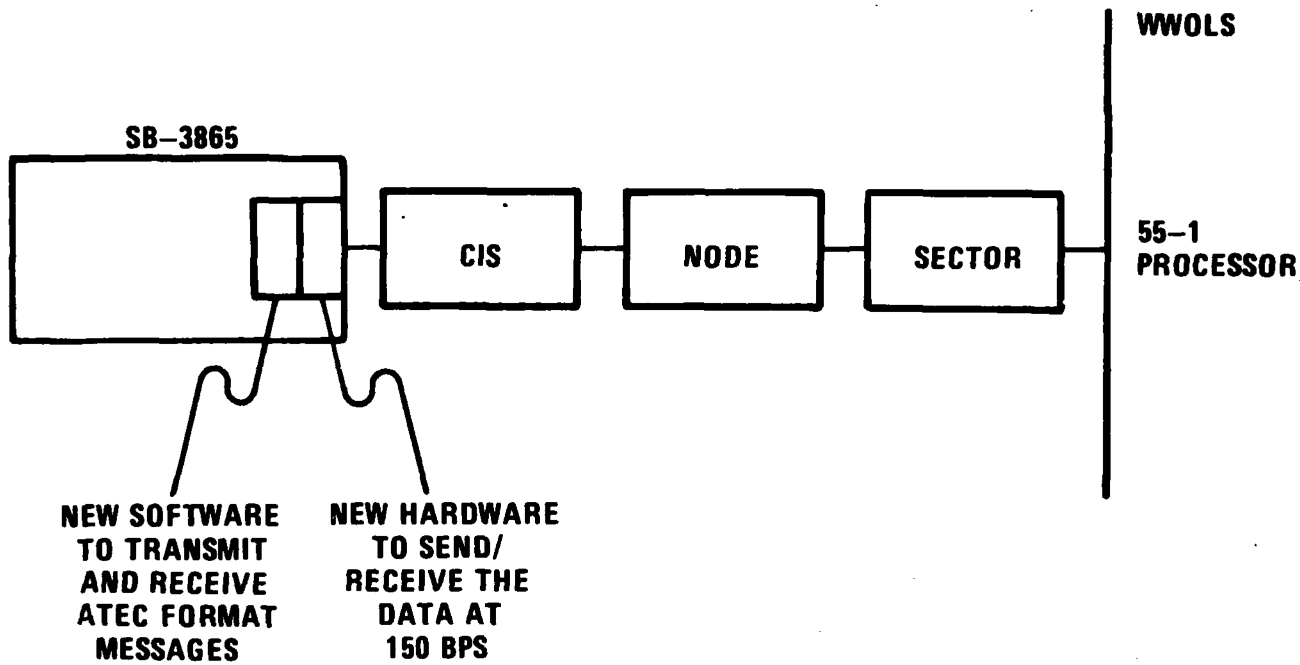
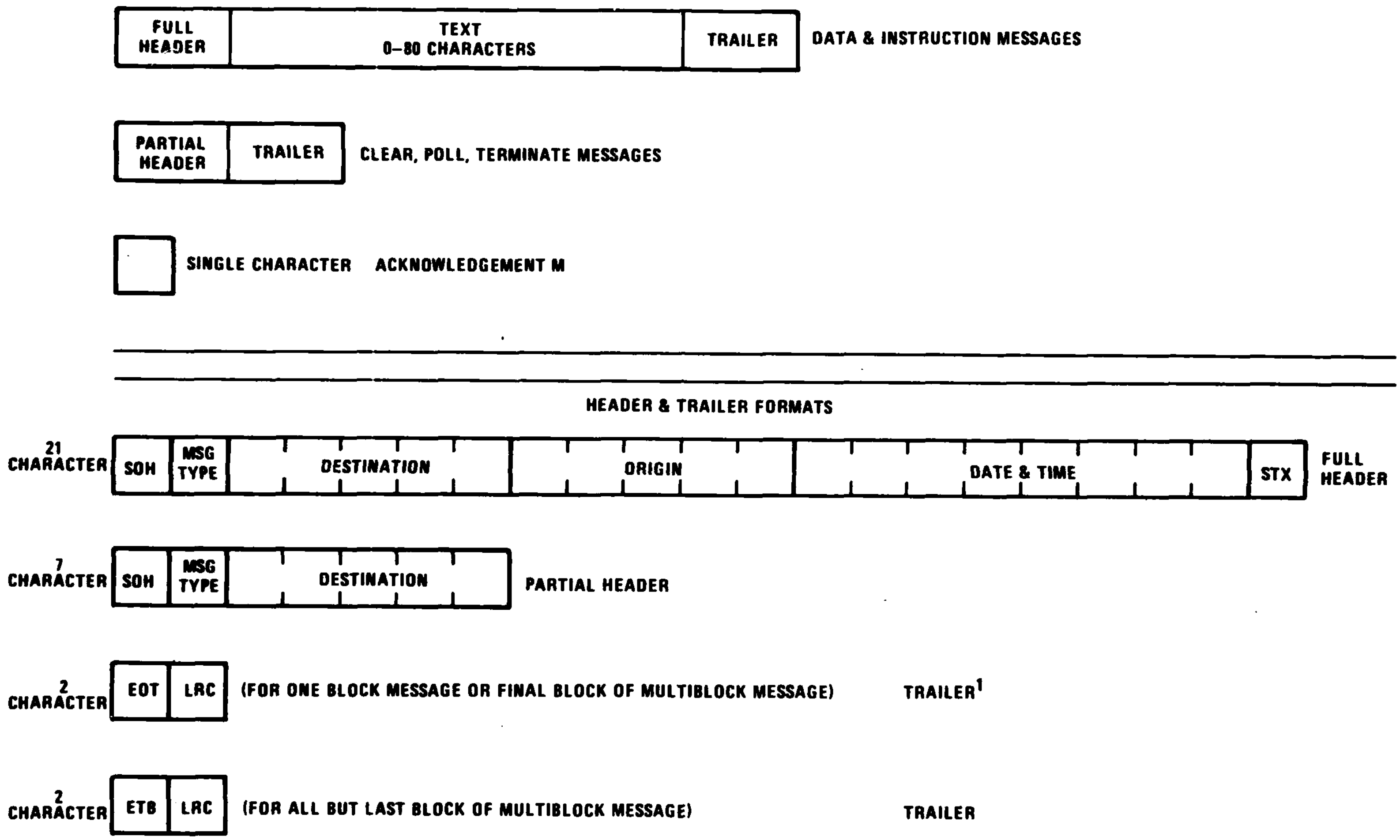


Figure 3-7. SB-3865 Data Acquisition



NOTES:

1. A "SYN" MAY COME BETWEEN EOT/EOB AND THE LRC CHARACTER
2. SUMMARIZED FROM THE ATEC 10,000 SPECIFICATION

Figure 3-8. ATEC Message Formats

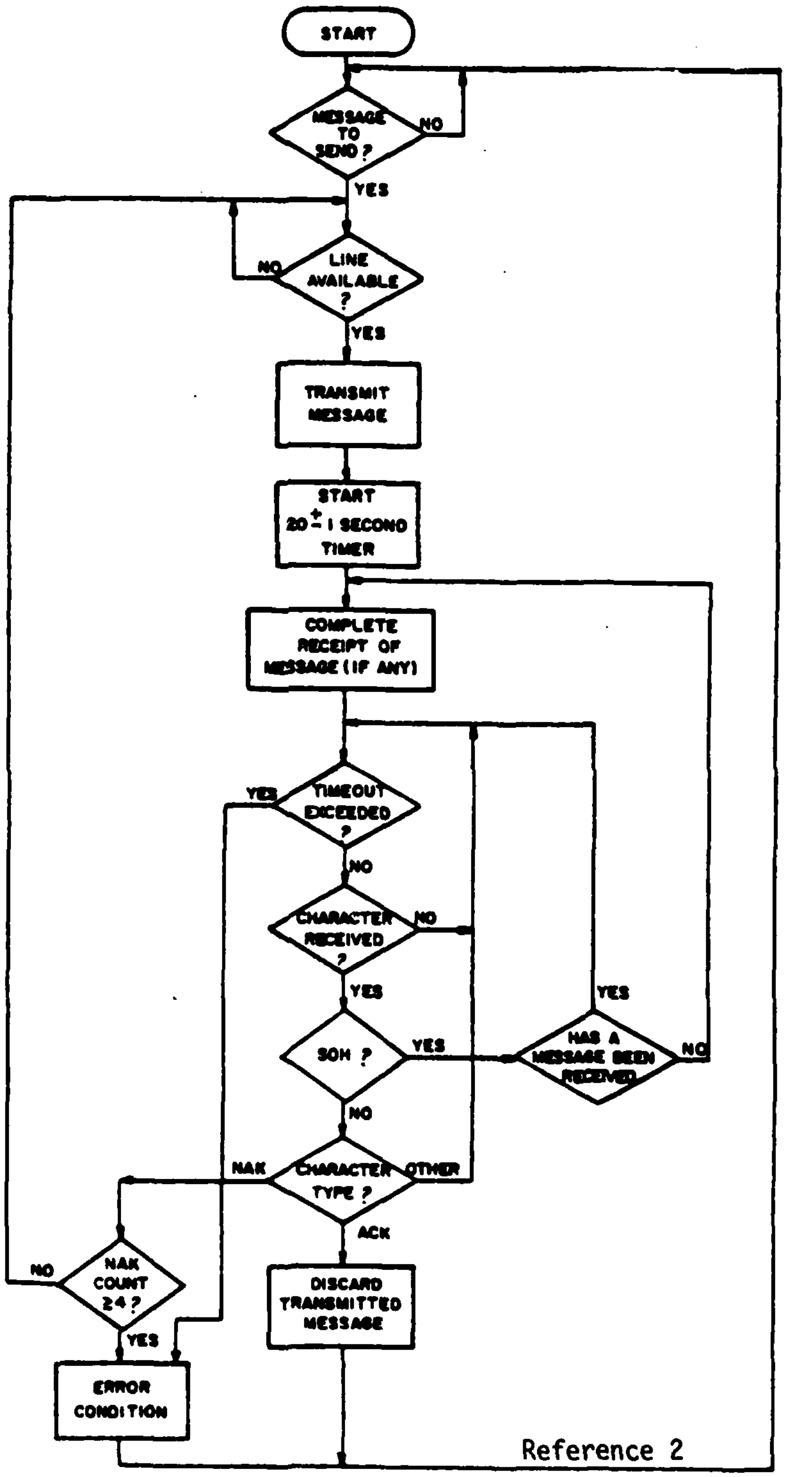
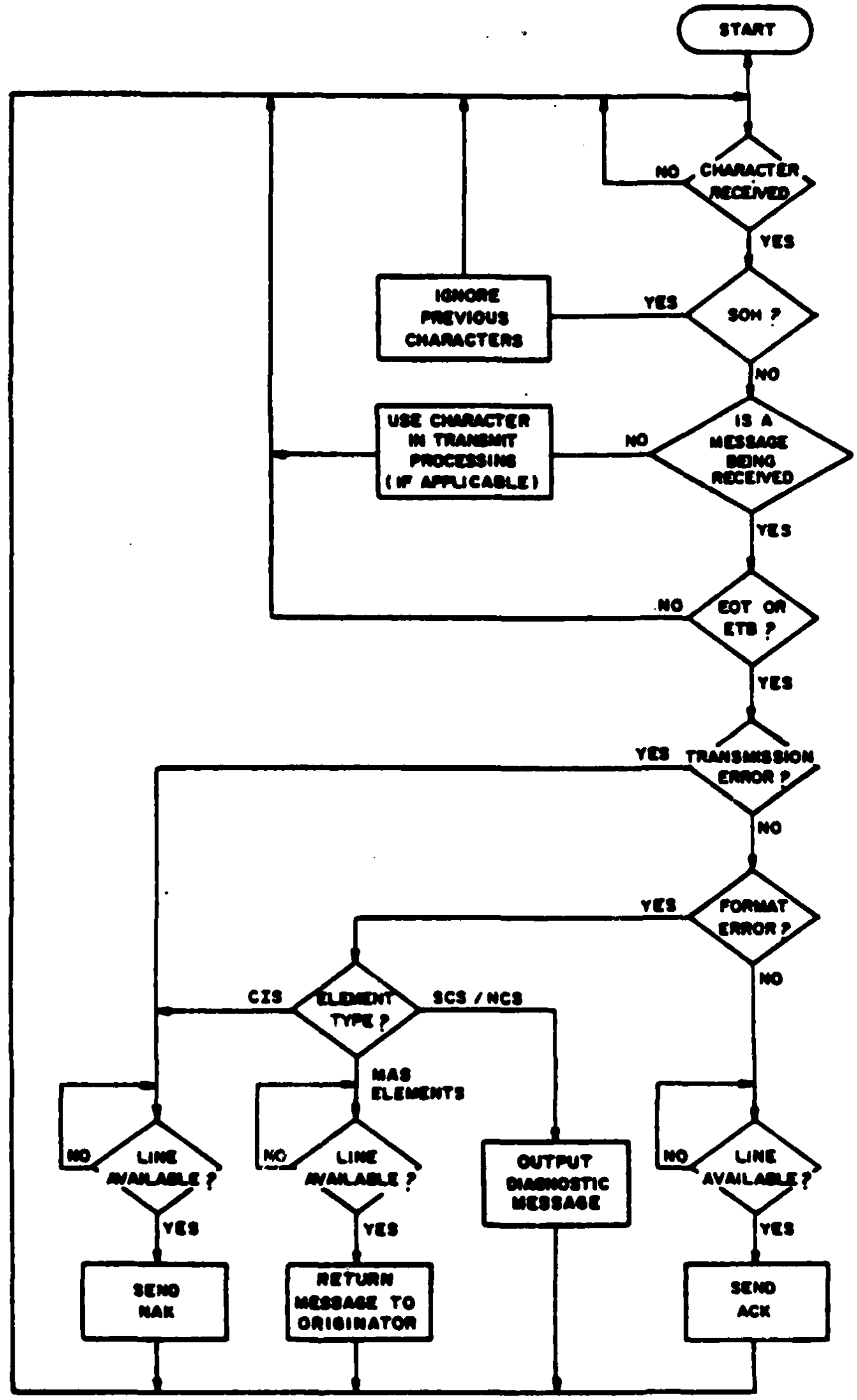


Figure 3-9. Standard Protocol Transmit Processing



Reference 2

Figure 3-10. Standard Protocol Receive Processing

3.2 UPWARDS COMMUNICATION FLOW IMPLEMENTATION

The recommendations for implementing the physical communication flow for upwards reporting of status and performance data is based on the results of the communications flow analysis. This analysis examined each system involved, characterizing the existing and/or planned command and control communication capacity and budgets, and looked at intersystem communication interfaces to augment data flow to the Theatre/ACOC level. For those systems that do not have upwards reporting command and control capabilities, alternatives were addressed. The ATEC system deployment and capacity/budget is examined for supporting additional telemetry of SYSCON data.

3.2.1 Information Flow Requirements

The information flow requirements based on the subsystem characterization and parameter analysis (See Section V) are summarized in Table 3-2. This table shows that the average communication loading is quite low; even the worst case values do not require significant communication capabilities.

The existing command and control communications systems are depicted in Figure 3-11. A portion of this figure shows the AUTODIN II reporting structure. This intra-network interface is accomplished using the Mode VI Binary interface with a choice of baud rates (75 x 2^n, n = 0,8, and 56 Kbps) available in the network. 19.2 KBPS was chosen as the NCC access line rate Estimates (pp. 3-17 of Reference 7) showed an average peak hour traffic load (receive direction) of approximately 6.5 Kbps, hence, the selection

TABLE 3-2. INFORMATION FLOW REQUIREMENTS

SUBSYSTEM		AVE LOAD
DIN II	(SNCC ⟶ ACOC)	26.7 BPS
TTC-39	VIA SYSCON CH.	8.8 BPS
SB-3865		3.84 BPS
DSCS	(NCE ⟶ ACOC)	1.5 BPS
	(TCP ⟶ CIS)	0.1 BPS
ATEC	SECTOR ⟶ ACOC	80 BPS

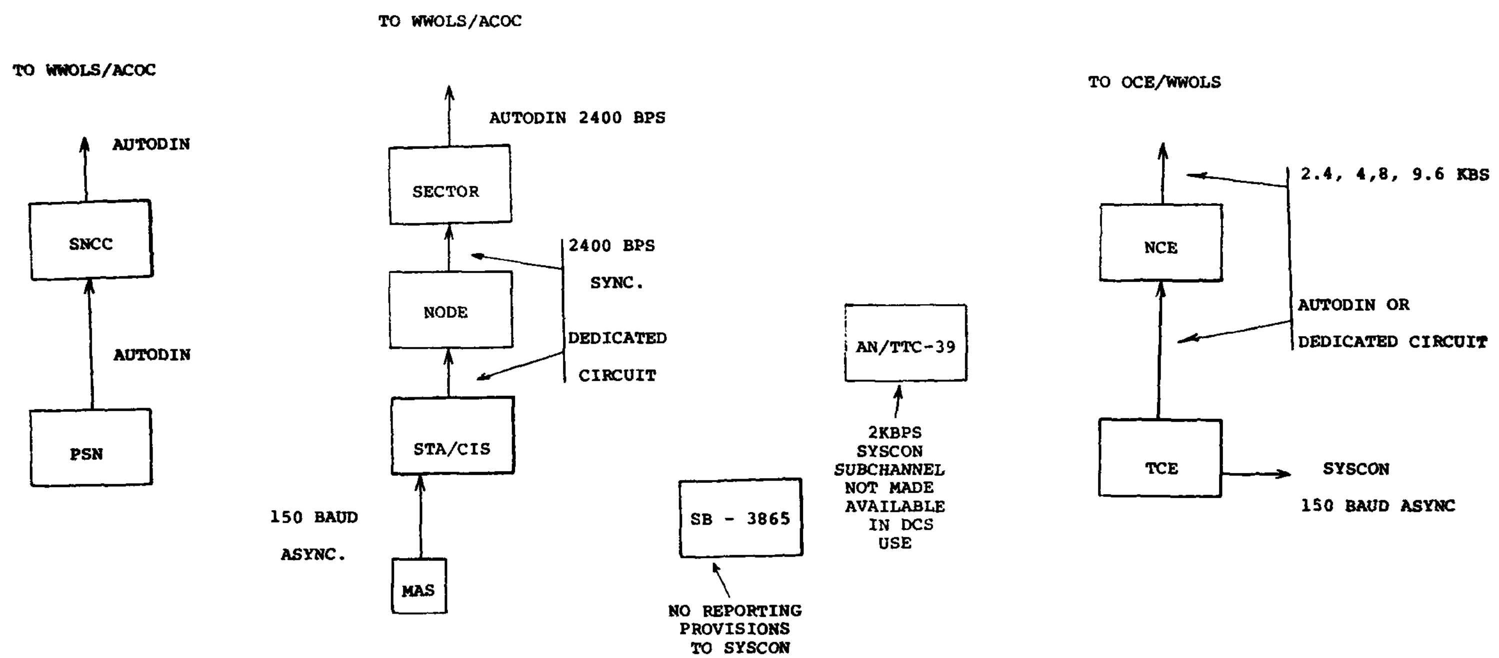


Figure 3-11. Existing Communication Flows

of 19.2 provides a peak load capability considerably above the hourly average. The data transfer protocol for this interface will be in accordance with the American National Standard for Advanced Data Communication Control Procedures (ADCCP) - Independent Numbering, American National Standard Institute. Our estimate of 26.7 bps worst case loading between the SNCC and the Theatre can be accomplished with any selection of available baud rates.

Also shown is the DSCS hierarchy interconnections. Planned to be available for this command and control interface is 2.4, 4.8, and 9.6 Kbps via AUTODIN or dedicated circuits. A SYSCON channel is available at the TCE to interface with the DCS TCF using asynchronous data at 150 baud. The average loading for SYSCON data reporting is negligible and no burden is placed on this interface.

The deployment of the AN/TTC-39 switches in the DCS does not provide access to the 2/4 Kbps SYSCON subchannel. Similarly, no provisions have been made to automatically receive status from the SB-3865 Telephone Switchboard. Thus, changes are required to collect this data. They are discussed in Section IV.

The ATEC reporting hierarchy is also shown in the figure. At the station level the Measurement Acquisition Subsystem (MAS) reports on 150 baud asynchronous full duplex, character oriented interfaces to the Communication Interface Set (CIS). The CIS reports to the Nodal Control Subsystem (NCS) using 2400 bps synchronous transmission. The SCS interface to the Theatre

level is by AUTODIN. The AUTODIN interface will be a full duplex digital data circuit operating at a rate of 2400 baud synchronous format and protocol as specified in DCA 370 - D175-1. The inter ATEC formats and protocol are defined in ATEC 10000, System Specification for Automated Technical Control, Volume I. Because of the wide deployment of ATEC subsystems (see Figure 3-12 which shows the 1982-1985 European ATEC Deployment Model) it becomes a prime candidate to support the command and control telemetry from other systems, particulary the AN/TTC-39 and SB-3865. Because of this possibility, a more detailed examination of the subsystem interface telemetry was made to ensure that additional loading was within the capacity of the planned interfaces.

3.2.2 ATEC Telemetry Analysis

A typical ATEC implemented station might be implemented with the ensemble of equipment shown in Table 3-3. It shows six subsystems, all of which provide on-occurrence status reports on the monitored communication system. References for the reporting frequency and message length are the ATEC 10000 Specification and the associated Appendices. The composite load from a single CIS, configured in the manner described, is 22 bps over a 15 minute interval. This is described as being the normal operating environment. In the deployment model, the SGT Sector and the SGT node have the most nodes and subordinate stations respectively. A closer look at the possible loads due to the MAS elements and some assumptions concerning the other uses of the telemetry system are in order based on those loads. The SGT Node has the most stations reporting to it and the deployment model for that

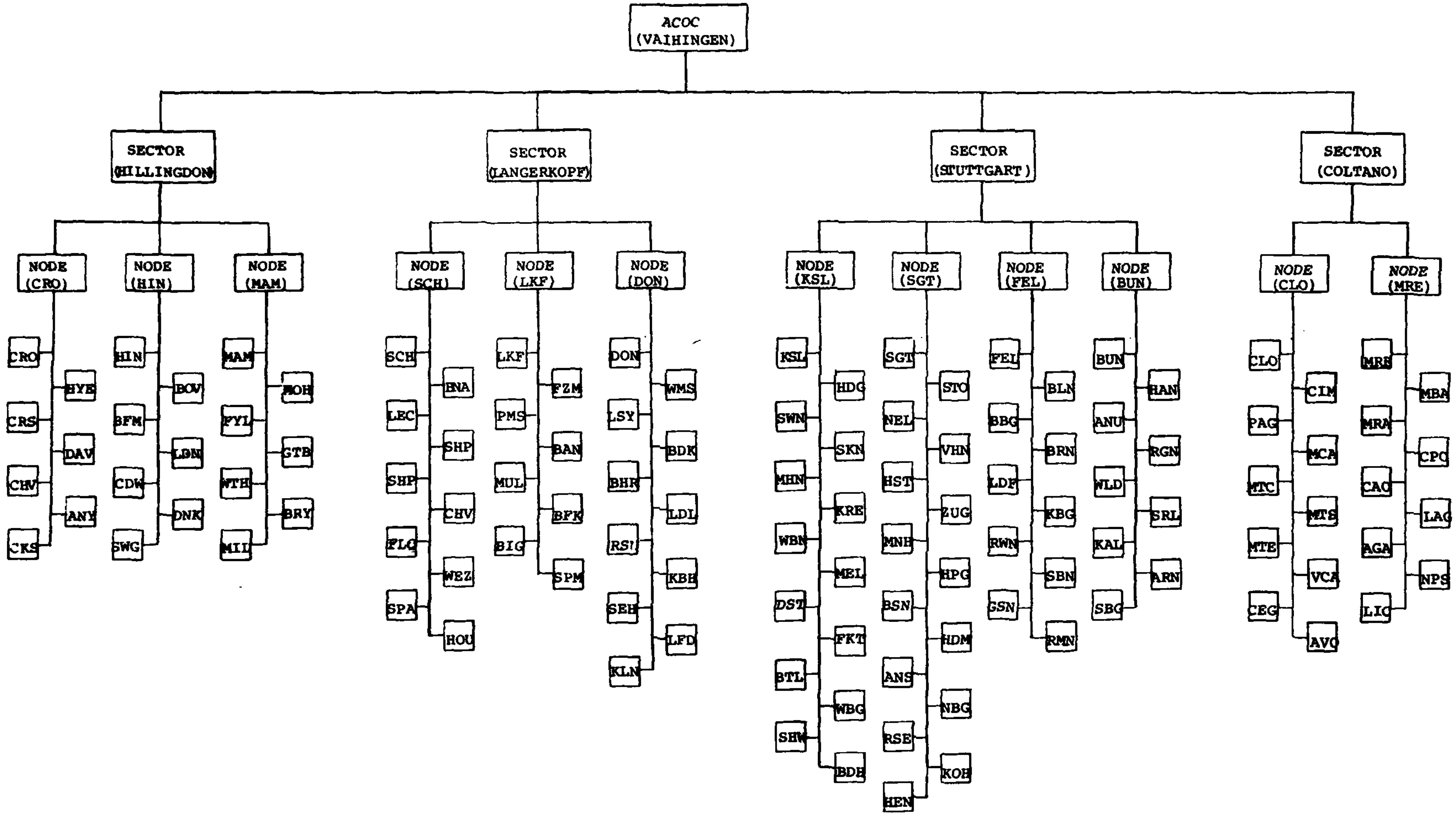


Figure 3-12. European ATEC Deployment Hierarchy (1982-1985)

TABLE 3-3. TYPICAL ATEC STATION DEPLOYMENT

FAULT REPORTING TO CIS

MAS ELEMENT	NO.	REPORTS IN 15 MIN.	MSG. LENGTH (CHAR.)	TOTAL CHAR.
IMS	1	10	40	400
DMS	1	10	40	400
BTS	1	5	50	250
WDS	1	5	122	610
ARS	1	1	17	17
PCS	1	1	20	20
		32		1697

ATEC PROTOCOL
HEADER + TRAILER = 21 + 2 = 23 CHARS.

32 MSGS x 23 =	736
	2433

AT 8 BITS/CHAR $\Longrightarrow$ 19464 BITS

15 MIN = 900 SEC.

$$\frac{19464}{900} = 22 \text{ BPS}$$

node is shown in Figure 3-13. This shown a total of 15 CIS's where 7 are connected directly to the node and 9 are polled by a CIS. Drawing from the ATEC 10000 Specification a node shall continue to function properly under a sustained load of 1200 bps from each of up to eight subordinate CIS's and traffic distribution shall be as follows:

- o 30% Exception Reports from MAS elements
- o 20% Routine Performance Data
- o 40% Responses to Inquiries
- o 10% Message Mode Traffic

Therefore, the maximum sustained loading condition of 360 bps would be associated with exception reports. The normal load from three CIS's (two polled and one directly connected), assuming each reporting 22 bps over the same telemetry link to the node, is (22 x 3) = 66 bps. This is a ratio of 66/360 or ~19% from normal to maximum sustained loading. Assuming that this same ratio or performance applies to all traffic, then the normal loading on any ATEC telemetry to the NCS is 19% of 1200 bps or approximately 230 bps. If the assumptions are valid, then ATEC telemetry links do offer reserve capacity to handle additional telemetry from collocated or adjacent systems for the purpose of upwards status reporting. With each of the station CIS/MAS elements ensembles reporting 32 messages in 15 minutes, there is a composite load of 480 messages in 15 minutes at the SGT Node due to MAS element exception reports.

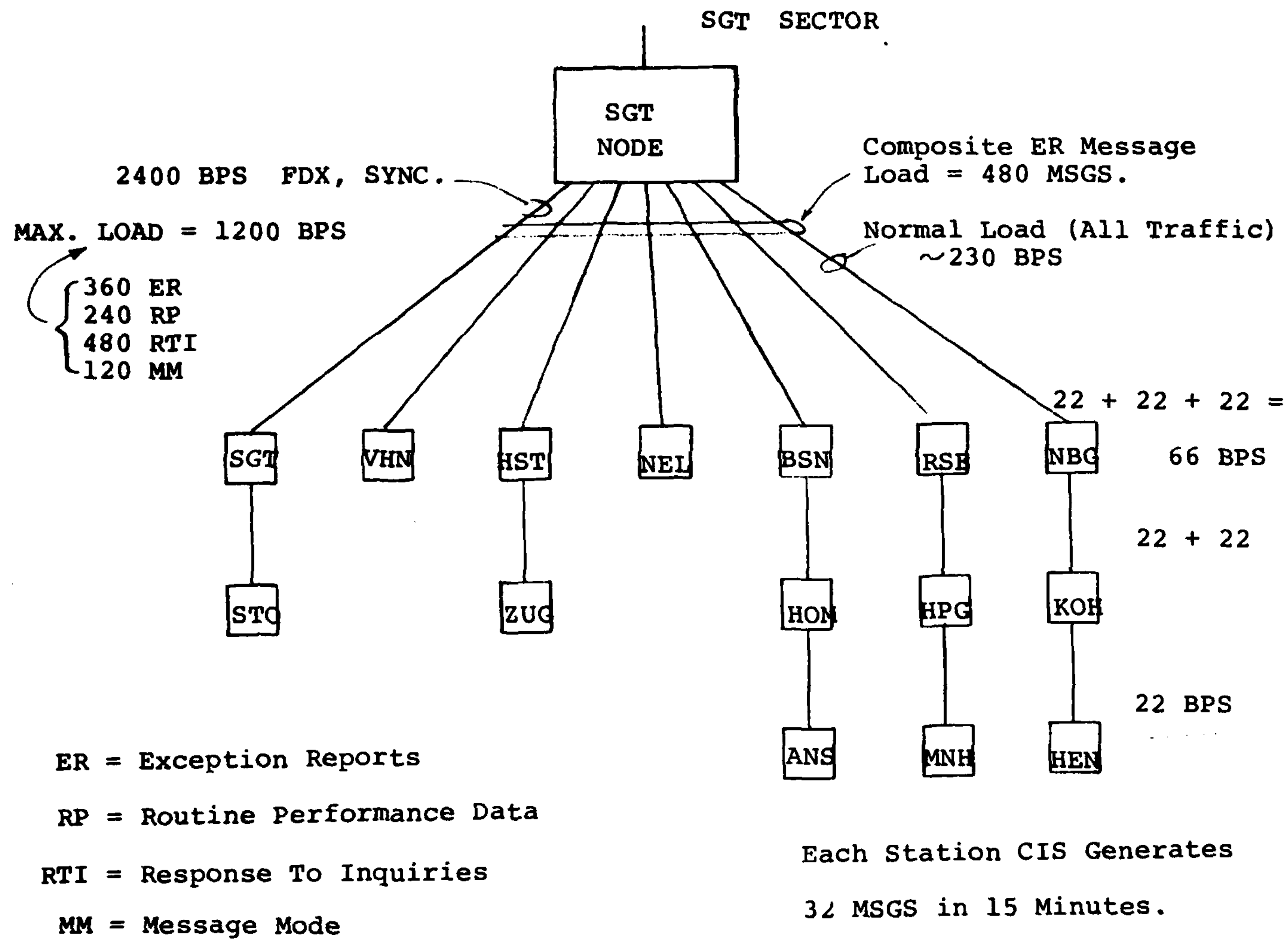


Figure 3-13. SGT Node Loading

Figure 3-14 shows four NCS reporting to the SGT sector. A similar analysis for each node yields the message load from the subordinate stations as shown. To estimate the loading at the sector due to exception reports, the following assumptions were made concerning the disposition of exception reports at the nodes:

- 70% of the exception reports (ER) are old or previously reported fault conditions.
- 20% of the ER's are correlated with other faults.
- 5% of the ER's indicate fault isolated or fault cleared conditions to be passed on to the Sector.
- 5% of the ER's produce a fault transfer message to the Sector.

Using the above assumptions, the message load at the SGT node produces 48 messages in 15 minutes to SGT Sector and the composite load from all nodes subordinate to the SGT Sector is 152 messages in 15 minutes. The heaviest load of 48 messages assuming 100 characters per message (including overhead) is 43 bps.

The disposition of the fault reports and fault transfers at the Sector is assumed to be as follows:

- 50% of the messages are concerned with fault isolations and as such are reported to the Theatre.
- 40% are correlated (or 80% of all fault transfers are correlated with other faults).

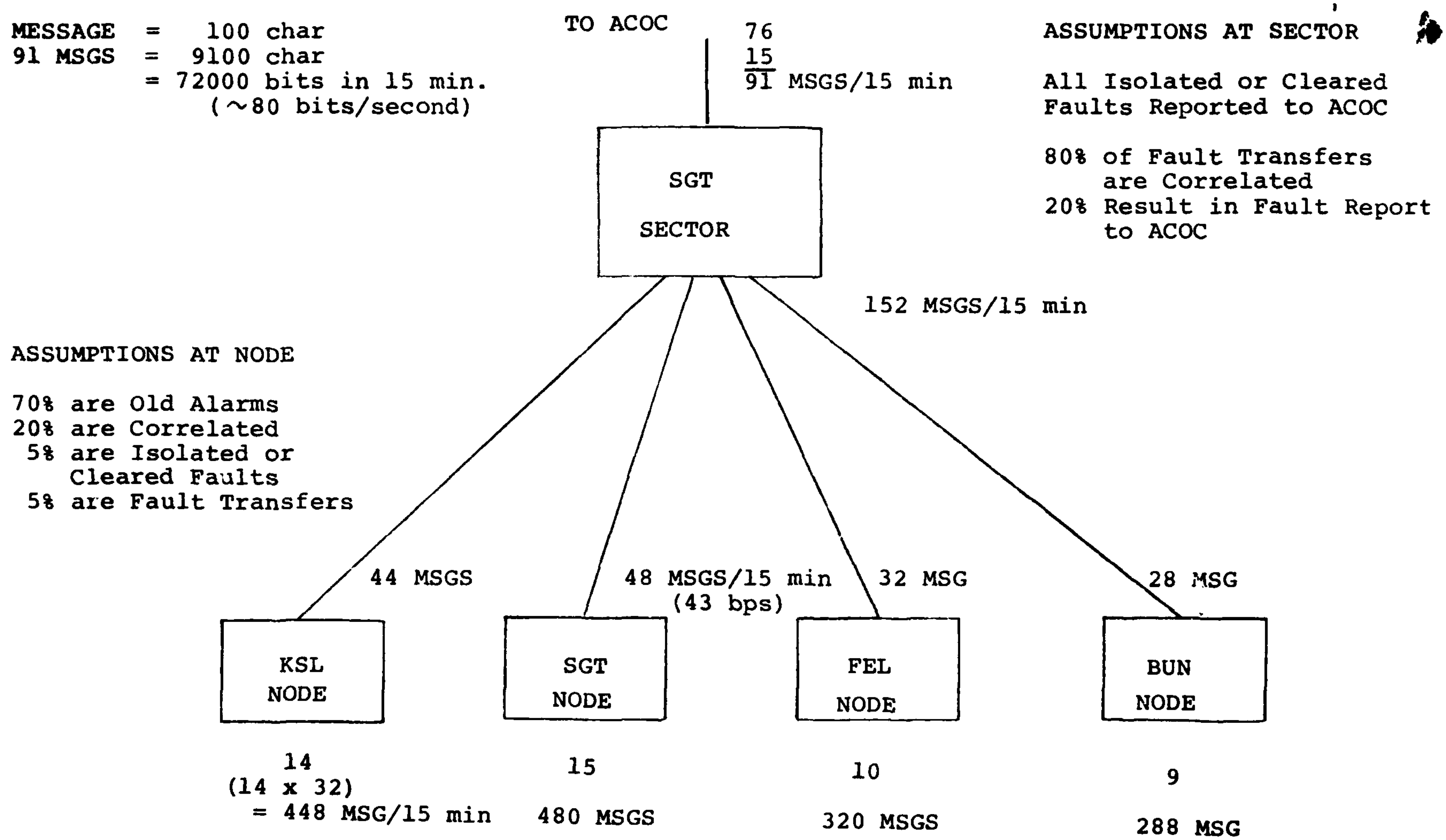


Figure 3-14. SGT Sector Loading

- o 10% result in fault isolation reports to the Theatre (20% of all fault transfer messages).

This results in a total of 91 fault reports being sent to the Theatre in a 15 minute period or a loading of approximately 80 bps from the SGT sector.

Applying the same rationale, Figure 3-15 shows the approximate composite load at the Theatre due to the performance assessments and fault isolation process in ATEC. The telemetry loading from the station to the NCS was assumed to be 30% due to the exception reports and 70% for other traffic. The loading from the NCS to the SCS is assumed to be 20% for fault reporting and fault transfers and 80% for other traffic. Between the SCS and ACOC, the total traffic load associated with fault reporting is 10%.

Several conclusions can be derived from this analysis. First, there is sufficient excess telemetry budget to support both the SB-3865 (average reporting load = 3.8 bps) and AN/TTC-39 (average reporting load = 8.8 bps) status and performance assessment reporting load. The composite average load due to nine TTC-39's is 80 bps or the composite average load due to approximately 50 SB-3865's is 190 bps. Second, if manual intervention is required for each reported fault to the next higher level, then the assumptions made in this analysis are too pessimistic and the actual load due to fault reporting will be much less. (Assuming one CRT terminal devoted exclusively to the reporting function, the call-up, review, editing approval, and send process will take up to one minute per message.) Thus,

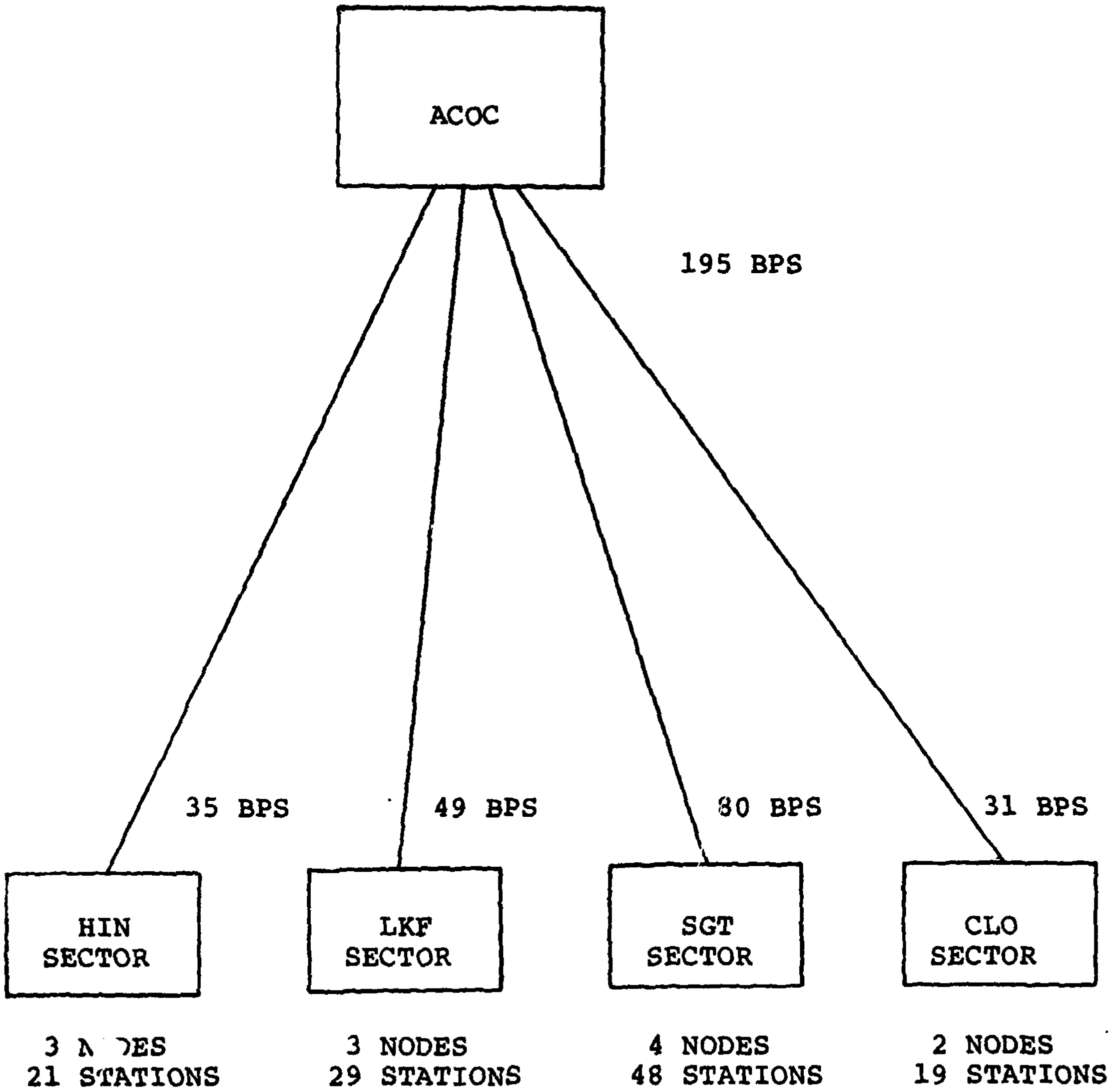


Figure 3-15. ACOC Loading

the ATEC system would have even greater excess capacity to serve other users.

3.2.3 Recommended Communications Flows

The recommended communications flows which were presented in the beginning of this section are summarized below. The AUTODIN II SNCC, DSCS NCE, and ATEC Sector report to ACOC using existing AUTODIN access lines. The TTC-39 SYSCON channels are consolidated at a centralized point and are routed to ACOC on a dedicated circuit. The SB-3865 reports are interfaced through the ATEC-CIS and ride the ATEC telemetry network arriving at ACOC via AUTODIN from the ATEC Sector.

3.3 PERFORMANCE OF OCE FUNCTIONS USING THE REAL-TIME AOC COMPUTER

Implementation of the Control Segment (CS) portion of DSCS in the mid 1980's will result in the physical relocation of the day to day DSCS operations from ACOC to the NCE's. The function remaining at the area level will be the dynamic management of DSCS resources such that they may be best utilized by the DCS and other DSCS users. The dynamic management function consists of:

- o Awareness of the status and configuration of DSCS resources.
- o Planning scheduled allocation of resources to requesting users.
- o Filling real time connectivity requests from the DCS management functions.

This function can be implemented on a dedicated computer facility or it can be made a portion of the recommended real-time ACOC Computer.

The recommended approach of combining it with WWOLS was agreed to by the DCEC personnel planning the deployment of the DSCS CS.

As previously stated, OCE functionality can be divided into three portions. Resources needed to support each portion are as follows:

1. Complete cognizance of all DSCS resources

   o Communication line interface to NCE (software and hardware)

   o Report/message processor programs

   o DBMS interface programs

   o Man-Machine Interface Management software (SW) (display file management)

   o DBMS

2. Planning scheduled allocation of resources to requesting users

   o A Man-Machine Interface and supporting SW; using CRT

   o Application SW that manages resources as functions of time

   o Application SW that selects links as functions of source, destination, bandwidth. (This should be at least partially implemented as a feature of a DBMS.)

   o Output message formatting SW

   o Input message decoding SW

3. Filling real time connectivity requests form the DCS management functions.

   - o Man Machine interface and supporting SW
   - o Output message formatting SW
   - o Input message decoding SW
   - o Application SW that selects links as functions of source, destination, bandwidth. (This should be at least partially implemented in a DBMS query facility.)

All three aspects of the DSCS dynamic management function are similar to those of terrestrial transmission system management. Therefore, it is recommended that the OCE function be incorporated directly into the Network Connectivity Control Function.

3.3.1 NCE to OCE-WWOLS Interface

DSCS plans indicate that a 9600 baud line will be required between the NCPs and OCE computers at DCAOC and ACOC. The NCEs of concern to the European DCS are those responsible for the manipulation of the Indian Ocean (IO) and Atlantic (LANT) satellites.

These are located at:

- o Landstuhl, Germany
- o Clark, the Phillipines
- o Two CONUS sites (Ft. Detrick, Ft. Meade or Northwest)

The types of connections under consideration are:

- o Dedicated and direct as possible.
- o Dedicated, but avoiding the satellite which is the subject of the reports being transmitted.
- o AUTODIN II.

The existence of dedicated circuits with assigned restoral priorities and preplanned altroutes guarantees that the necessary telemetry paths are available when needed.

The argument in favor of the second type of connection is simply that it is undesirable to transmit control/report information via the medium which shou should be controlled or reported upon. Stress or failure situations, to management information path could be irrevocably blocked leaving the satellite subequally unreportable and uncontrollable until connectivity changes are implemented.

The use of AUTODIN, on the other hand, guarantees that all information to be relayed in either direction will be transferred by the most direct working path if system capacity is available.

AUTODIN may use the subject satellite if it is working and provides the most direct route, or it can configure around a broken (or fully loaded) satellite path in favor of a less direct but available route.

The recommended interface is the use of AUTODIN to provide NCE to OCE-WWOLS

communications.

All of the NCE's and both of the OCE's of concern to European System Control are convenient to AUTODIN. AUTODIN itself will provide built-in maintenance of the communication paths required and will automatically control relay of information according to the AUTODIN priority scheme.

3.4 LOCATION OF AN AUTODIN II SUB NETWORK CONTROL CENTER (SNCC)

The three AUTODIN II nodes in Europe are an extension of the CONUS DIN II network. As such, it is intended that these nodes report to the Network Control Center (NCC) in CONUS. However, the European ACOC must also be congnizant of all conditions present in the European DCS. Because a three node network exists in Europe, the status of the European portion of the network should be available to ACOC Europe. This permits management of the European Network even if connection to CONUS is lost. Also, it permits attention to be focussed on the European portion of the Network. To support this requirement, management information concerning the European DIN II nodes can be made available to the European ACOC in either of two ways:

1) All reports from packet switching nodes (PSN's) in Europe are sent to the NCC at DCAOC where they are processed and reduced such that management information pertinent to Europe is then transmitted to the European ACOC.

2) All reports from the PSN's in Europe are routed to a Sub-Network Control Center (SNCC) at ACOC in Europe where they are used to support the DIN II management function in Europe. These reports are then readdressed and passed to the NCC in CONUS with only the destination address modified.

Detailed implementation criteria of these two methods, along with recommendations for implementation are provided below.

1) All reports from European DIN II nodes are routed to the NCC in CONUS. The NCC filters the information it receives and transmits that which is appropriate to DCAOC via the AUTODIN II network in the form of 55-1 reports. This same information is also required for network management at the ACOC in Europe and would be transferred via AUTODIN.

2) All reports from European DIN II nodes are routed to a proposed SNCC at the ACOC facility in Europe. These reports are filed, then readdressed and transmitted to the NCC in CONUS via AUTODIN where they are processed according to the system design spec. The SNCC is proposed to be an exact copy of the NCC in both hardware and software with the following exceptions:

- o The address look-up table in each European PSN would be modified to contain the SNCC address instead of the NCC address.
- o The SNCC software would be modified such that is would readdress and transmit all reports received to the NCC in CONUS.

The selection of option two above is recommended for the following reasons:

a) The placement of SNCC in Europe provides for autonomous monitoring and control of European AUTODIN II. Thus, failures of the CONUS NCC or loss of connection to it doesn't remove European control capability.

b) The placement of a SNCC in Europe allows the European AUTODIN control function to be implemented in an already defined fashion on an already designed meachine without modifying or adding anything to the ACOC complex.

c) European AUTODIN control will be identical to CONUS with respect to reports received, displays and utilities provided and control actions available.

d) European information will be readily available to the control functions in Europe without tying up trans-Atlantic communications. If desirable, the reports could be relayed to CONUS at a lower priority to allow more urgent traffic access to DIN resources.

e) The information received by the European ACOC is that with which it is concerned. If the DCAOC was the first WWOLS level computer to receive DIN information, it would have to sort out that which is relevant to Europe and transmit it to ACOC. This would be a change in the proposed operation of the DCAOC-WWOLS computer facility. The recommended implementation requires no changes to any of the WWOLS computer facilities.

3.5 OPERATION OF THE AUTODIN II SUBNETWORK CONTROL CENTER (SNCC) IN EUROPE

The SNCC will be an exact duplication of the NCC hardware and software with one addition to the software:

- All reports received from the Packet Switching Nodes (PSN) will be readdressed by the SNCC and transmitted to the NCC in CONUS.

The general operating scenario for European AUTODIN switches and management will be as described below.

All European PSN's will operate exactly as designed for CONUS implementation. They will generate periodic and exception reports detailing the operation of the network. The destination address for these reports will be the SNCC, however, but this should have no implication in the operation of the PSN. Reports received at the SNCC will be filed for processing and then readdressed and retransmitted to the NCC.

The report contents will be processed by the SNCC software as designed and implemented for the NCC. This implies that a European AUTODIN II Control Function will be available to the ACOC independent of the global AUTODIN Control Function at DCAOC. To this end, the displays supporting the European AUTODIN will be of the same format and hierarchy as defined for the NCC, but will summarize only the European nodes. Similarly, the control actions available to the control function will be the same as are available to the NCC in CONUS. (It may be desirable to limit via software or table contents the PSN's over which the European AUTODIN Control Function has jurisdiction. Whether or not this requires significant (or even any) changes depends upon the implementation of the NCC software. It is expected that the topology of the network to be controlled is built into the system via tables rather than being in the code.

Because the SNCC will be an almost exact copy of the NCC, the information transferred from the SNCC to the ACOC-WWOLS complex will be of the same variety as that which is defined for delivery from the NCC to DCAOC-WWOLS.

In summary, the SNCC will provide exactly the same management and control functions for the European PSN's as the NCC is to provide for the entire DIN network.

3.6 AUTOVON DATA BASE

The AUTOVON data base contains all the information about the network's configuration and status necessary to perform theatre level AUTOVON control functions. This data is contained in seven file types, as follows:

- Network configuration file
- Switch equipment status and history files
- Switch configuration files
- Switch traffic files
- Trunk group status files
- Trunk group traffic files
- Critical user access status file

The interrelation of these files is shown in Figure 3-16. The overall size of the data base is 38,000 bytes. The network configuration file (Table 3-4) contains the basic layout of the network and those data items which are common throughout the network. It provides the controller with

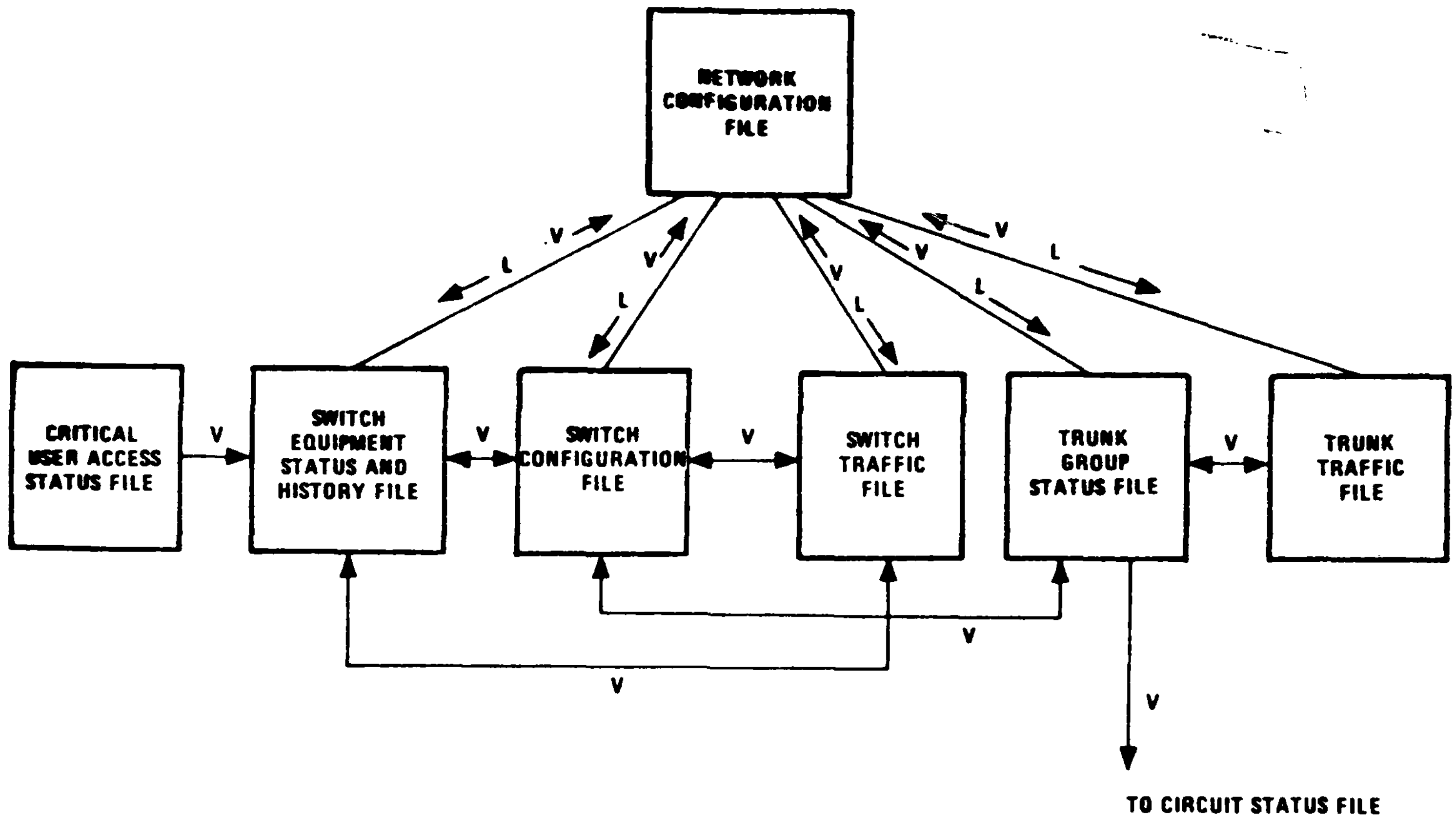


Figure 3-16. AUTOVON Data Base

TABLE 3-4. NETWORK CONFIGURATION FILE

ITEM	COMMENTS	SIZE (BYTES)
Switch names	Provides correspondence between DCS station name and network logical switch number. Three (3) ASCII characters per switch.	27
Connectivity Table	Provides forward pointer from network connectivity to logical trunk group names. Two (2) BCD digits for each end of each trunk group.	50
Call inhibit tables	Tables used by switches to prevent any calls forwarded to certain switch codes. Used to implement destination code cancellation. Thirty (30) NYX tables of 50 NNX entries, BCD.	2265
	TOTAL	2342

Number of such records - 1

Total Bytes - 2342

a quick reference of the overall network configuration and, more importantly, forms the root of the information tree containing all the network information. From the network configuration file, pointers can be used to locate any information about the network and how it interrelates. The network configuration file also contains a set of call inhibit tables. Call inhibit tables are used in each TTC-39 switch to prevent calls to certain switch codes. Typical entries on these tables would be non-existant switches, or switches which are completely out of service. Call inhibit tables are not subscriber class marks, but are universally applied to any call passing through a switch. In the general case, each switch could have a different set of call inhibit tables, in which case they would be part of the individual switch configuration. However, because of the way call inhibits are used there will be a large amount of commonality between switches. Therefore, it is reasonable to keep the details of a set of call inhibit tables in a centralized location with an index to those tables in the individual switch files. Another data type very similar to the call inhibit table is the zone restriction table. The major difference is that zone restriction is a subscriber classmark. As such, it would not normally be used in theatre level control and it is therefore excluded from the theatre data base.

A switch equipment status and history file (Table 3-5) exists for each TTC-39 or SB-3865 switch. The status information is required to keep the controller informed of what switch resources are available for meeting current communications needs. The history portion of the file is used by the controller to find out the normal restoral time for any given

TABLE 3-5. SWITCH EQUIPMENT STATUS AND HISTORY FILE

ITEM	COMMENTS	SIZE (BYTES)
Status and history subrecord for each reportable piece of equipment, containing the following:		
Number operating	Provides indication of operating resource.	1
Number stand by	Provides indication of reserve resource.	1
Number failed	Provides indication of currently inoperable resource.	1
Failure rate	Total number of failures/total operating time required by 310-130-2.	4
Average restoral time	Used by controller to determine whether or not a response to a stress is appropriate.	1
Average repair time	Same as restoral.	1
Number of accumulated failures; daily, monthly, yearly	Used by controller to be aware of abnormal failure problems. Provides controller with insight as to what may be expected to fail, so that he does not place excessive demands on weak equipment.	3
Failure time integral	Total time a piece of equipment has been in failed state - provides measure of equipment availability.	6
	SUBTOTAL	18

TABLE 3-5. SWITCH EQUIPMENT STATUS AND HISTORY FILE (CONT)

Reportable Equipment:

Power units	
Tenley controllers	TTC-39 only.
Switching controller group	
Master timing generator	
Trunk signalling buffers	TTC-39 only.
Digital receivers	
DTMF receivers	TTC-39 only.
MF receivers	TTC-39 only.
DTMF/MF senders	TTC-39 only.
IMU	TTC-39 only.
LKG	TTC-39 only.

TOTAL (TTC-39) 234
(SB3865) 72

Number of such records - TTC-39 - 9
SB-3865 - 45

Total Bytes (9 x 234) + (45 x 72) = 5346

failure. If the normal restoral time is short, no other control action would be necessary. The historical data is also required for making management threshold decisions as defined in DCAC-310-130-2.

The switch configuration file (Table 3-6) exists for each TTC-39 switch. It provides the controller with a small subset of the tables which control the TTC-39. It is used by the controller to determine the routing and traffic control procedures currently in effect at each switch.

The switch traffic file (Table 3-7) contains the current values of those traffic parameters which are switch related (as opposed to trunk related). These data items are useful for analysing the characteristics of the traffic load. This file exists for each TTC-39 and SB-3865 switch.

The trunk group status file (Table 3-8) contains information on which circuits make up the trunk group and what their operating condition is. This file exists for each trunk group in the network, and is required to provide the controller with knowledge of the trunk capabilities currently available in meeting communications requirements. It also provides the cross reference between the logical trunk group name used the the TTC-39 switches and the CCSD identifier used the the transmission system.

The trunk traffic file (Table 3-9) contains the current value and the history of traffic parameters which are related to trunk groups. These

TABLE 3-6. SWITCH CONFIGURATION FILE

ITEM	COMMENTS	SIZE (BYTES)
Routing Table	20 switches destination switch code 2 bytes type routing 1 byte trunk group 1 byte	80
Trunk groups in operations	Logical names of all trunk groups terminating on this switch.	28
Call inhibit tables	Listing of which call inhibit tables from network configuration file are in operation in this switch.	20
Line load control status		1
Satellite control parameter		1
	TOTAL	130

Number of such records - 9

Total Bytes - 9 x 130 = 1170

TABLE 3-7. SWITCH TRAFFIC FILE

ITEM	COMMENTS	SIZE (BYTES)
Calls blocked by precedence	Last hours total	5
Dial tone delay (1 second)	Last hours total	1
Total switch accesses	Last hours total	4
Calls completed	Last hours value for each node	20
	TOTAL	30

Number of such records - TTC-39 - 9

SB-3865 - 45

Total Bytes - 54 x 30 = 1620

TABLE 3-8 . TRUNK GROUP STATUS FILE

ITEM	COMMENTS	SIZE (BYTES)
Trunk group ID	Logical. An number from 1-127 used by the TTC-39 to identify the group.	1
Digital Portion CCSD	Eight alphanumeric identifier used by transmission system to identify the circuit which carries the TDM digital group.	8
Transmission rate	Number of channels/speed of transmission of the digital portion of the trunk group.	1
Digital error rate	Quality of digital transmission as measured by the TTC-39's decoded of the common signalling channel.	1
CCSD for each analog trunk	Each analog trunk is a seperately idetifiable circuit at the transmission system interface. There could be up to 50 trunks in a trunk group, each with its own 8 character CCSD.	400
Transmission status	For each circuit, 1 byte to indicate status as seen by the switch netowork, and as seen by the transmission system.	51
Analog signalling status	Indicator of whether signalling is using digital common channel, or inband.	1
Failure reports	Last twenty reports (1 crt screen full) or 24 hours, whichever is less. Informs controller of recent history of trunk group.	440
	TOTAL	903

Number of such records - 25

Total Bytes - 25 x 903 = 22575

TABLE 3-9. TRUNK TRAFFIC FILE

ITEM	COMMENTS	SIZE (BYTES)
Current readings of all traffic parameters	Details used to solve unusual traffic problems.	48
Filtered values - measured call congestion, offered traffic	Primary parameter for alarming traffic overload.	2
Alarm and warning level thresholds	Values for call congestion and offered traffic which initiate alarms.	4
Hourly values of call congestions	Used by controller to identify demand trends, past 24 hourly values.	24
	TOTAL	78

Number of such records - 25

Total Bytes - 25 x 78 = 1550

parameters provide the controller with the basic information regarding the patterns of traffic in the network, which is required in order to analyze the operational situation and determine appropriate control actions.

The critical user access status file (Table 3-10) contains the identity of all critical users and the status of their access status. By monitoring the access status, the controller can be made aware that critical subscriber connectivity is being maintained.

3.7 NETWORK CONNECTIVITY DATA BASE

The Network Connectivity Data Base permits the necessary displays to be generated within ACOC. This implies that the contents include all of the data recommended for use at the ACOC for real time control functions and that the relationships between system elements necessary for stress isolation, impact summaries, and available resources identification may be identified. The work is an extension of that presented in Reference 28.

The intent has been to define the data base as if it is a part of one global data base. Therefore, any system element may be traced to the responsible area. For example, each circuit file entry identifies the station which is the facility control office. The station file in turn identifies the node, sector, and ACOC responsible for that station.

TABLE 3-10. CRITICAL USER ACCESS STATUS FILE

ITEM	COMMENTS	SIZE (BYTES)
Loop ID	Switch number and physical loop number (BCD).	6
Loop circuit CCSD		8
Telephone number		3
Location	Physical location of subcriber.	10
Access status	Operational/non-operational condition of access circuit, terminal equipment.	½
Security requirement	Access circuit security requirements, needed for rehoming.	½
Subscriber instrument type	TA 341, WECO 500D, etc., needed for rehomong.	1
Signalling classification	Dial pulse, DTMF, etc., needed for rehoming.	1
	TOTAL	30

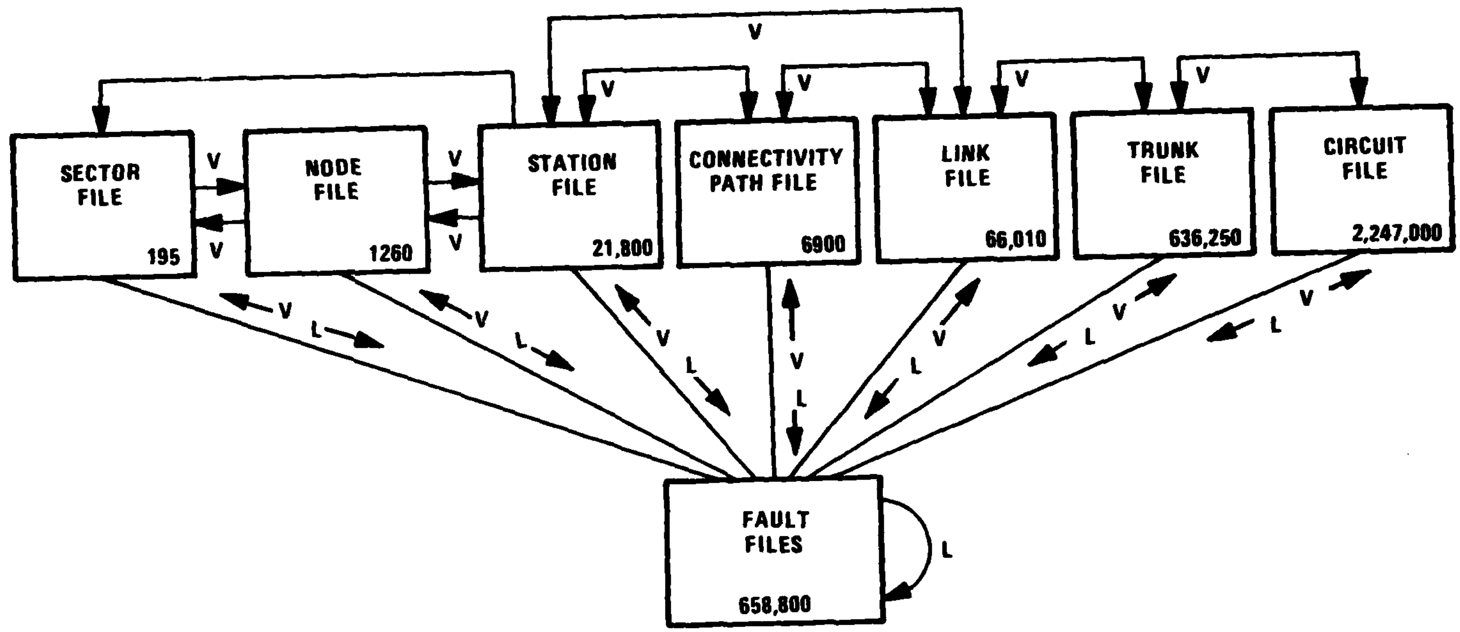
The files included in the data base and their links are shown in Figure 3-17. The links identified by "L" are direct links with a pointer to the related record. The links identified by "V" are virtual links. This implies that the linkage exists by virtue of including a key for the related record, such as the sector including the names of each node it is related to. The contents of these files is described in Tables 3-11 through 3-18. The use of the items included is identified in the comments column. The sizing of each item is described in Table 3-19. This is consistant with the current DCA data base. A brief description of the overall use of each file type follows.

Sector File--The sector file identifies the reporting nodes and the reporting status of the sector. (See Table 3-11.)

Node File--The node file identifies the reporting stations, responsible sector, and reporting status of the node. (See Table 3-12.)

Station File--The station file identifies the status of both the reporting capabilities and communication capabilities of the stations. Any outage associated with the station will be linked to this file. Note that TCE's will be included as stations in this list. (See Table 3-13.)

Connectivity Path File--The connectivity path file is linked to all links which comprise it to permit assessing the status of the total connectivity path. Because a large number of links may exist in some connectivity paths, space is allocated for multiple faults. (See Table 3-14.)



V = VIRTUAL LINK

L = EXPLICIT LINK

TOTAL SIZE: 3,638,059 BYTES

Figure 3-17. Network Connectivity Files and Links

TABLE 3-11. SECTOR FILE CONTENTS

Item	Comments	Bytes
Sector ID		3
Node List (Up to 6 Nodes)	For operator reference.	18
ACOC ID	Locates the sector within the global data base.	3
Sector Reporting Status	Indicates if any reports are overdue or if the telemetry from the station is out of service.	1
Fault Detail Pointer	To first of a string of fault reports allowing that fault report to be accessed.	6
CCSD of ATEC Telemetry to ACOC	Permits the details of that telemetry path to be looked up if it must be restored or its condition is in question.	8
		39

Number of Such Records - 5 (5 sectors/area)

Total Bytes = 5 x 39 = 195

TABLE 3-12. NODE FILE CONTENTS

Item	Comments	Bytes
Node ID		3
Responsible Sector	Locates the node within the global data base.	3
Responsible Area	Locates the node within the global data base.	3
Station List (Up to 6)	For operator reference.	18
Node Reporting Status	Indicates if any reports are overdue or if the node-sector telemetry is out of service.	1
Fault Detail Pointer	To first entry of a string of fault reports, allowing that fault report to be accessed.	6
CCSD of ATEC Telemetry to Sector	Permits the details of that telemetry path to be looked up if it must be restored or its condition is in question.	8
		42

Number of Such Records - 30 (5 sectors/area x 6 nodes/sector)

Total Bytes = 30 x 42 = 1260

TABLE 3-13. STATION FILE CONTENTS

Item	Comments	Bytes
Station Name		3
Station Status	Indicates if the station is totally or partly out of service or if a HAZCON exists.	1
Link ID, Status, Destination, Spare Trunks (for up to 16 links)	Identifies each link terminating at the station, its status and destination and if there are any spare channels. Used for generating status displays and for the operator to manually investigate alt routes.	176
Fault Detail Pointer	Points to first fault report against the station, allows that fault report to be accessed.	6
Responsible Node	Locates the station within the global data base.	3
Responsible Sector	Locates the station within the global data base.	3
Responsible Area	Locates the station within the global data base.	3
AUTODIN Site Flag	Indicates that an AUTODIN switch is at this site, used in status display generation.	1
AUTOVON Site Flag	Indicates that an AUTOVON switch is at this site, used in status display generation.	1
ATEC Equipped Flag	Indicates that ATEC exists at this site, used to determine if communications with ATEC are possible.	1
Manned/Unmanned Flag	Indicates if the station is a manned site, to determine what actions are possible or if there can be communications with an operator.	1
CCSD of ATEC Telemetry to Node	Permits reviewing that circuit to determine how it can be restored or other items relative to its operational status.	8

TABLE 3-13. STATION FILE CONTENTS (Continued)

Item	Comments	Bytes
Station Reporting Status	Indicates that the telemetry to the site is out of service or that reports are overdue.	1
Time Report Due	Indicates that the time that an overdue report should have been submitted.	4
Reporting Fault Pointer	Points to first fault report relating to a telemetry failure.	6
		218

Number of Such Records - 5 stations/node x
5 nodes/sector x
4 sectors/area = 100

Total Bytes = 100 x 218 = 21,800

TABLE 3-14. CONNECTIVITY PATH FILE

Item	Comments	Btyes
Connectivity Path ID		2
Terminating Stations	Of Connectivity path, identifies the path.	6
Links and Terminating Stations (Variable - up to 12)	All of this data appears on the display.	132
Fault Pointer, Direction 1	Location, r/t, link, trunk, ckt, pointer - up to 4 such faults. Gives basic information on fault in direction 1 to be used in formatting the connectivity display and gives pointer to the fault report record.	68
Fault Pointer, Direction 2	Location, r/t, link trunk, ckt, pointer - up to 4 such faults. Same as above except for Direction 2.	68
		276

Number of Such Records - 25 (based on applying our definition of connectivity paths to Europe; see Figure)

Total Bytes = 25 x 276 = 6900

Link File--The link file is linked to subordinate trunks which would be impacted by its failure, and also to the connectivity path which is impacted by a link fault. There is sufficient information in the file for a summary link status. (See Table 3-15.)

Trunk File--The trunk file is linked to subordinate circuits which would be impacted by its failure, and also to the supplying link which is partially degraded by a trunk failure and can cause a trunk failure. The file contains sufficient information for a summary trunk status and an impact summary if the trunk fails. (See Table 3-16.)

Circuit File--The circuit file is linked to the supplying trunk, which can cause its failure, and to the trunk record if it is a VFCT. The file contains sufficient information for a circuit status display. (See Table 3-17.)

Fault File--The fault file contains data related to a specific fault. It there are multiple reports filed on one fault, then the Fault Detail pointer (link, trunk, or circuit) will link those records together. (See Table 3-18. If this fault is superceded by a higher level fault, then it will be marked closed, and a link will be made to that higher level fault. If this fault supercedes another, then the fault detail pointer to superceded faults will link these together. In addition, all reports for faults at the same station and all reports for faults at the same node will be linked together.

TABLE 3-15. LINK FILE CONTENTS

Item	Comments	Bytes
Link ID		5
Terminating Stations	Stations at each end of the link, for information and for alt route sorting.	6
Trunk List (up to 16)	Trunk IDs for trunks riding this link - for impact summary, alt routing information.	96
DOD (Direction 1)	Degree of degradation (i.e., out or degraded)	1
Fault Pointer (Direction 1)	Points to first fault report, direction 1.	6
DOD (Direction 2)	Same as for Direction 1.	1
Fault Pointer (Direction 2)	Same as for Direction 1.	6
ETR and DTG	Estimated Time to Restore and Date/Time group when Estimate was made.	11
Highest RP	Highest restoration priority carried by the link to establish criticality of temporary/ permanent restoral.	2
Connectivity Path ID		2
HAZCON		1
Data Base Distribution	List of all stations (2), nodes (2), sectors (2), and areas (2) to receive DB updates for this link. Use addressing as in ATEC 10000 Spec.	24
		161

Number of Such Records = 410*

Total Bytes = 410 x 161 = 66,010

* Based on Reference 28

TABLE 3-16. TRUNK FILE CONTENTS

Item	Contents	Bytes
Trunk ID		6
VFCT CCSD	Cross reference to VFCT identifier if this is a VFCT.	8
Link Assignments	Link number (5 bytes), terminating stations (6), super-group number (1), group number (1), type of appearance (terminating or through group)(1), assigned direction (transmit receive)(1), and whether TCF, ET, etc. (3) up to 10 links. Permits identifying carrying links to check link status and to reflect a partial outage of the link when the trunk is out.	180
CCSDs Carried	List of CCSDs (8 bytes) and RP (1 byte) of each, up to 24.	216
Reroute ID #1 and Flag	Identifies the trunk which is preplanned for restoral of this trunk, and whether it is activated.	7
Reroute ID #2 and Flag	Identifies either a trunk other than the preplanned reroute which was used to restore this trunk, or a trunk which has preempted this trunk. A flag indicates that this field is idle, or that this trunk has been rerouted or preempted.	7
Degree of Degradation (DOD), Direction 1 and Fault Location	Identifies whether entire group or partial group in direction 1 is affected, whether this is a partial degradation, out of service or a HAZCON.	4
Degree of Degradation (DOD), Direction 2 and Fault Location	Same as above, except it is for direction 2.	4

TABLE 3-16. TRUNK FILE CONTENTS (Continued)

Item	Comments	Bytes
Fault Pointer, Direction 1	Points to first fault report for direction 1.	6
Fault Pointer, Direction 2	Points to first fault report for direction 2.	6
Route ID	Identifies route which this trunk rides.	5
Data Base Distribution	List of all stations (6 x 3), nodes (3 x 4), sectors (3 x 4), and areas (2 x 3) to receive DB updates. Use addressing as in ATEC 10000 Spec.	48
Control Responsibility		3
Networks Impacted (VON, DIN, ...)	Identifies which control functions need the data.	2
PMP		
Related Route		6
Monitoring Rgrd Flag		1
		509

Number of Such Records = 1,250*

Total Bytes = 1,250 x 509 = 636,250

* Based on Reference 28

TABLE 3-17. CIRCUIT FILE CONTENTS

Item	Comments	Bytes
User	Identifies name of person to contact relative to this circuit.	12
Phone Number	Permits calling user.	10
RP	Restoration Priority used in impact analysis of outage.	2
VFCT Number	Identifies carrying trunk if this is a data circuit or the trunk record if this is a VFCT.	8
Preempting CCSD and Flag	Identifies that this circuit has been preempted by the identified circuit.	9
Trunk and Channel Number	For each segment and terminating station - up to 6. Permits identifying serving trunks for fault diagnosis. e.g. 44 JM 10 10/12,LKF,SGT.	84
Reroute ID #1 and Flag	Identifies the circuit which is preplanned for restoral of this circuit, and whether it is activated.	9
Reroute ID #2 and Flag	Identifies either a circuit other than the preplanned reroute which was used to restore this circuit which has preempted this circuit. A flag indicates that this field is idle, or that this circuit has been rerouted or preempted.	9
Degree of Degradation, Direction 1, and Fault Location	Identifies whether there is a complete outage or a degradation, and where the fault is. Direction 1 for circuit level faults.	4
Degree of Degradation, Direction 2, and Fault Location	Identifies whether there is a complete outage or a degradation, and where the fault is. Direction 2 for circuit level faults.	4

TABLE 3-17. CIRCUIT FILE CONTENTS (Continued)

Item	Comments	Bytes
Fault Pointer, Direction 1	Points to first fault report for direction 1.	6
Fault Pointer, Direction 2	Points to first fault report for direction 2.	6
Data Base Distribution	List all stations (6 x 3), nodes (3 x 4), sectors (3 x 4), and areas (2 x 3) to receive DB updates. Use addressing as in ATEC 10000 Spec.	48
Control Responsibility		3
		214

Number of Such Records = 10,500*

Total Bytes = 10,500 x 214 = 2,247,000

* Based on 7,400 circuits in unclassified portion of 1978 DCS connectivity data base, intra and inter Europe. This was taken to be 90% of total circuits. A 25% growth factor was added.

TABLE 3-18. FAULT FILE CONTENTS

Item	Comments	Bytes
Fault ID		6
Station with Fault		3
DTG (of original report)		7
Severity	Link, trunk, or circuit level.	1
ID of Circuit, Trunk, or Link Effected		8
Direction	Direction of outage.	1
RFO	List of each reported, up to 3.	9
ETR and DTG	The estimated time to repair and the time at which the report was made.	11
DOD	Degree of degradation	1
DTG of Fault Closure		9
Station Submitting Closing Report		3
RP or Highest RP	Serviced by failed capability.	2
Comments	Narrative field of fault report	80
ID of and Pointer to Fault Superceding	Identifies a fault report which superceded this fault.	12
Related Fault Pointer	Points to the first fault report related to this fault report, e.g., a transmission fault causing this AUTOVON fault.	6

TABLE 3-18. FAULT FILE CONTENTS (Continued)

Item	Comments	Bytes
Fault Detail Pointer (link, trunk or circuit)	Points to the next fault report on this link, trunk or circuit.	6
Fault Detail Pointer (to superceded fault)	Points to the first report of a lower order which is superceded by this fault, or to the next fault which was superceded by the same fault as this report.	6
Fault Detail Pointer (to next fault report at the same station)		6
Fault Detail Pointer (to next fault report at the same node)		6
		183

Number of Such Records = 3,600*

Total Bytes = 3,600 x 183 = 658,800

TABLE 3-19. SIZE OF ITEMS STORED IN NETWORK CONNECTIVITY DATA BASE

ITEM	DESCRIPTION	#ASCII CHARACTERS = #BYTES
ACOC, Sector, Node, Site ID	3 letter DCA site name.	3
Reporting Status	1 letter coded for O.K.	1
Pointers	6 byte field allocated for use in internal file/DBMS structure.	6
CCSD	8 characters per DCA standards, e.g. DUUC 9865.	8
Station Facility Status	1 letter coded for O.K., degraded, out of service.	1
Link ID	5 characters per DCA standards, e.g. M0912.	5
Site Flag	1 character only, equipped (E), or not equipped (N).	1
Time	4 digits of time, e.g., 0930.	4
Connectivity Path ID	2 character identified, 00-99.	2
Trunk	6 characters, 44GL09	6
DOD	1 character encoded as is site or facility status.	1
ETR	4 characters of amount of delay until restoral.	4
DTG	Julian data (3 digits) plus hours and minutes (4 digits).	7
RP	Restoration Priority 00,1A...4G	2
HAZCON	1 character indicates whether or not a HAZCON exists.	1
Fault ID	Node reporting (3 characters) and 3 digit number.	6

3.8 SUMMARY

Section III has described the rationale for the implementation of the recommended system described in Section II. The alternatives considered and the reasons for selecting particular approaches have been given. Changes to equipment and the amount of added equipment have been minimized, while planned capabilities have been used where practical.

The software and hardware required for the recommended system are described in Section IV.

SECTION IV

FUNCTIONAL DESIGN AND COST ESTIMATES

This section presents the functional design and corresponding cost estimate for the implementation of the recommendations of Section II and III The areas affected by our recommendations include:

- o Parameter acquisition
- o Subsystem interfaces
- o Information flows
- o PA/SD/I algorithms

Both hardware and software aspects of the functional design are treated in this section as follows:

- o Functional flow charts and, where appropriate, hierarchy charts have been prepared for new and modified software. These charts detail the functions and modules required to implement the recommended modifications.
- o The modules are then sized in the context of the functions required of them.
- o The hardware modifications and augmentations recommended are similarly detailed and analyzed.
- o The software size estimates are translated into the number of man days required for implementation.
- o The number of man days required to design the recommended hardware is estimated.

- o The cost of the hardware units required to implement the recommendations is estimated.

4.1 FUNCTIONAL FLOWS

An overview of the recommended system wide functional flow is presented in Figure 4-1. Individual functional flows have also been prepared for all recommended additions or changes to software in existing or recommended DCS subsystems. Each flow describes the set of functions performed as the subject subsystem responds to a specific input in order to generate a set of outputs. Hierarchy charts have also been prepared for the AUTOVON, Network Connectivity and Theatre Control Functions to be implemented using the ACOC-WWOLS computer facility. A summary of the functional flows prepared is contained in Table 4-1. The functional flows themselves and a brief description of each follow in the order presented in the table. The structure of the hierarchy charts and the details of the functional flows have been developed in an iterative fashion to assure consistency within each level of the hierarchy and completeness across all control functions.

4.1.1 Modifications to the NCC which Result in a Subnetwork Control Center

The SNCC will have all the same software as the NCC with one exception:

- o All reports received from the European PSN's will be stored and retransmitted to the NCC in CONUS.

Figure 4-2 presents the functional flow describing this change to the NCC software.

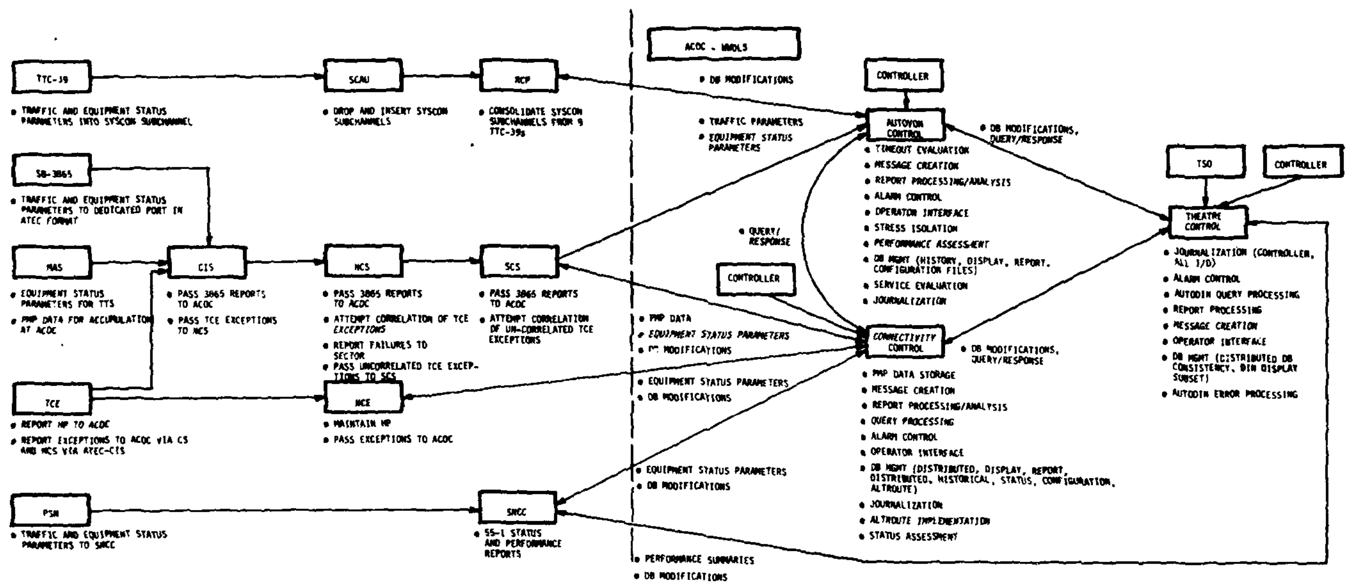


Figure 4-1. Overview of System Wide Functional Flow

TABLE 4-1. SUMMARY OF FUNCTIONAL FLOWS

AFFECTED SUBSYSTEM	FUNCTIONAL FLOW SUMMARY
1) SNCC	PASS ALL REPORTS RECEIVED TO THE NCC.
2) SB-3865	FORMAT AND TRANSMIT TRANSMISSION AND STATUS REPORTS TO AUTOVON CONTROL FUNCTION VIA ATEC IN ATEC FORMAT. MAINTAIN BIDIRECTIONAL PROTOCOL.
3) TTC-39	FORMAT AND TRANSMIT RECOMMENDED REPORTS TO AUTOVON CONTROL FUNCTION VIA THE SYSCON SUBCHANNEL ON IST'S TO LANGERKOPF.
4) SYSCON CHANNEL ACQUISITION UNIT	THIS FUNCTIONALITY REQUIRED OF THE SCAU IS ENTIRELY IMPLEMENTED IN HARDWARE.
5) REPORT CONSOLIDATION PROCESSOR	ORGANIZE REPORTS FROM NINE TTC-39 SWITCHES.
6) DSCS-TCE	FORMAT AND TRANSMIT EXCEPTION REPORTS TO ATEC-NCE VIA THE CIS AND THE CONNECTIVITY CONTROL FUNCTION VIA DSCS-CS. FORMAT AND TRANSMIT HISTORICAL PARAMETERS TO CONNECTIVITY CONTROL FUNCTION VIA DSCS-CS.
7) DSCS-NCE	RECEIVE AND RECORD HISTORICAL PARAMETERS AND EXCEPTION REPORTS FROM TCE. TRANSMIT SAME TO THE CONNECTIVITY CONTROL FUNCTION VIA AUTODIN II.
8) ATEC-CIS	RECEIVE SB-3865 TRAFFIC AND STATUS REPORTS FROM THE SB-3865 UNIT. RELAY SAME TO AUTOVON CONTROL FUNCTION. RECEIVE DSCS EXCEPTION REPORTS FROM THE DSCS-TCE DESTINED FOR THE ATEC-NCE.
9) ATEC-NCS	RELAY SB-3865 REPORTS TO THE AUTOVON CONTROL FUNCTION. CORRELATE DSCS EXCEPTION REPORTS. RELAY DSCS EXCEPTION REPORTS TO THE ATEC-SCS.
10) ATEC-SCS	RELAY SB-3865 REPORTS TO THE AUTOVON CONTROL FUNCTION. RECEIVE DSCS-CS EXCEPTION REPORT SUMMARY FROM NCS.
11) WWOLS-ACOC	IMPLEMENTATION OF THE AUTOVON, NETWORK CONNECTIVITY AND THEATRE CONTROL FUNCTIONS.

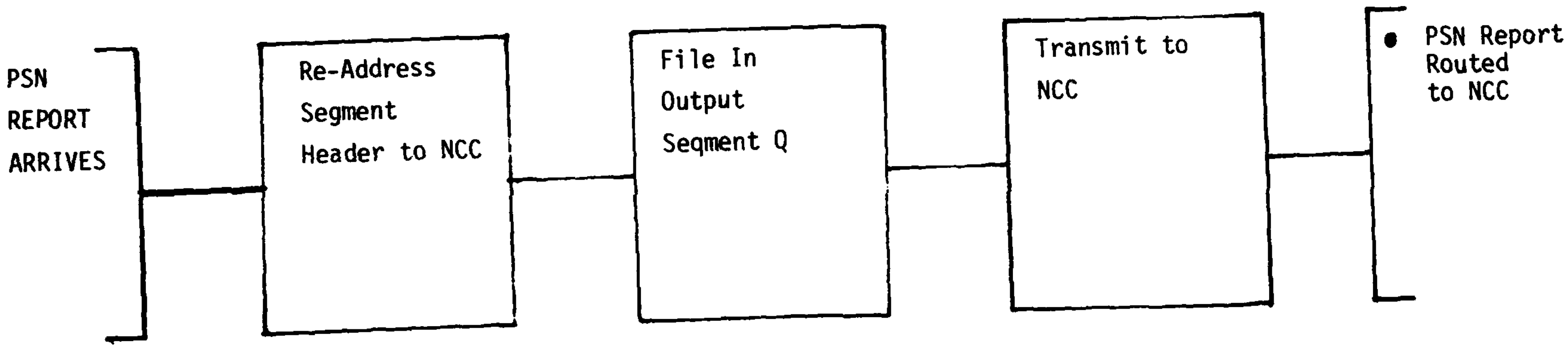


Figure 4-2. At the AUTODIN SNCC - Receipt of PSN Report

4.1.2 Modifications to the SB-3865

Parameter Collection

As currently designed, the SB-3865 collects the following traffic parameters:

- o Total number of originated loop calls
- o Number of trunk group originations
- o Number ATB's in block
- o Number preempts/trunk group

It is recommended that the SB-3865 be modified to collect the following status parameters:

- o Access lines
- o HW subsystems
    - a. Termination subsystem
    - b. STED (Seely Trunk Encryption Device)
    - c. MMI (Man-Machine Interface)
    - d. Memory
    - e. Matrix
    - f. Control complex
    - g. Clock
    - h. Power unit

According to the SB-3865 spec, there will be diagnostic programs that will be able to identify failing hardware to the LRU when used by a craftsman.

Parameters Reported

It is recommended that the ULS be modified to report the traffic and status parameters it collects.

A. Traffic parameters will use ATEC report formats.

1. Total number of originated loop calls
2. Number of trunk group originations offer d
3. Number ATB's encountered (ultimate blockage)
4. Number preempts/trunk group

B. HW status parameters will use ATEC report formats.

1. Trunks
2. Access lines
3. Encryption device
4. Hazcon - Loss of one copy of duplex equipment or ability to switch
5. Switch degradation
6. Switch failure

HW and SW Modifications

A. HW Mods

1. Provide a port on the switch to which ATEC format reports will be routed such that this can then be connected into ATEC-CIS.

2. Provide communication line to the CIS.

B. SW mods - Change the applications software:

1. To report traffic parameters:

   a. Read and record values periodically

   b. Transmit values

   c. Zero out values to start next reporting period

2. To report hardware status parameters:

   a. Modify diagnostic and routine software such that the results are buffered for transmission in addition to informing local attendant.

   b. Put the results into the reporting channel for transmission.

The functional flows for these changes/additions to the SB-3865 software are presented in Figures 4-3 and 4-4.

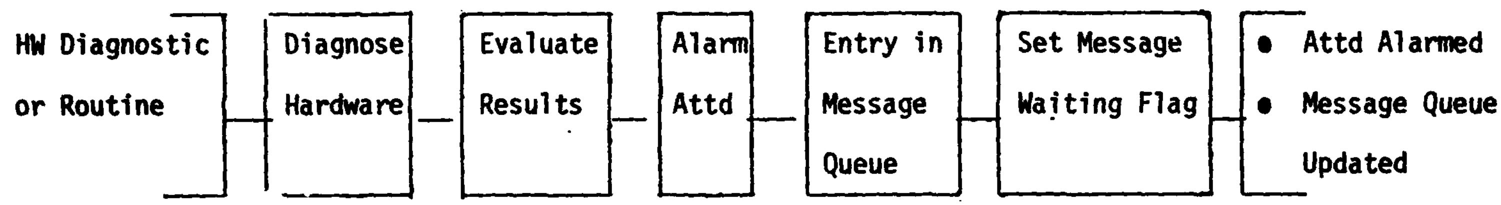
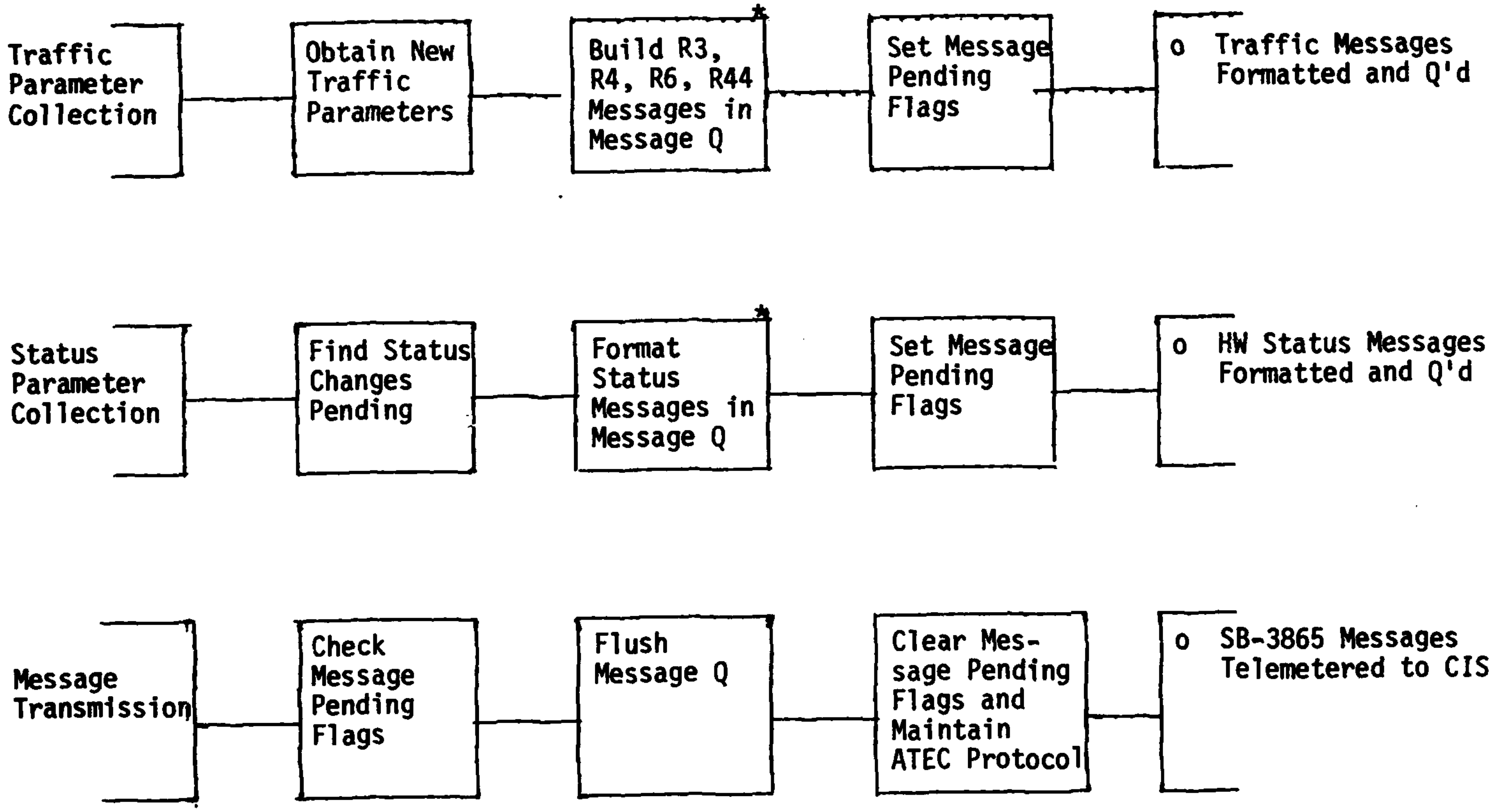


Figure 4.3. Within SB3865; Software Changes to Record Hardware Status Changes



*uses ATEC Format

Figure 4-4. Within SB-3865; Message Formatting and Transmission Control

4.1.3 Modifications to the TTC-39 Parameter Collection and Reporting

It is recommendedthat the TTC-39 be made to collect and report the following additional parameters:

1. Trunk routine failure - Use ICD-004 format RXX
2. Detection of "Ring around Rosey" condition - Use ICD-004 format R60

This information should be recorded and placed into the SYSCON overhead channel as is done for the other parameters recorded and transmitted by the TTC-39.

Hardware Modifications

As it has been recommendedthat the Syscon Channel be used to route all TTC-39 reports to Langerkopf for breakout by a channel reconfiguration unit, no hardware modifications to the TTC-39 switch itself are required.

Software Modifications

1. Routine software must be modified to buffer the indications of single trunk failure. This indication must also be transferred to the system control subchannel.
2. TTC-39 software must be modified to report the detection of the "Ring around Rosey" condition. Field A of ICD-004 report format R60 (invalid message request) can be used for this purpose.

Figures 4-5 and 4-6 detail the functional flows for these sortware modifications.

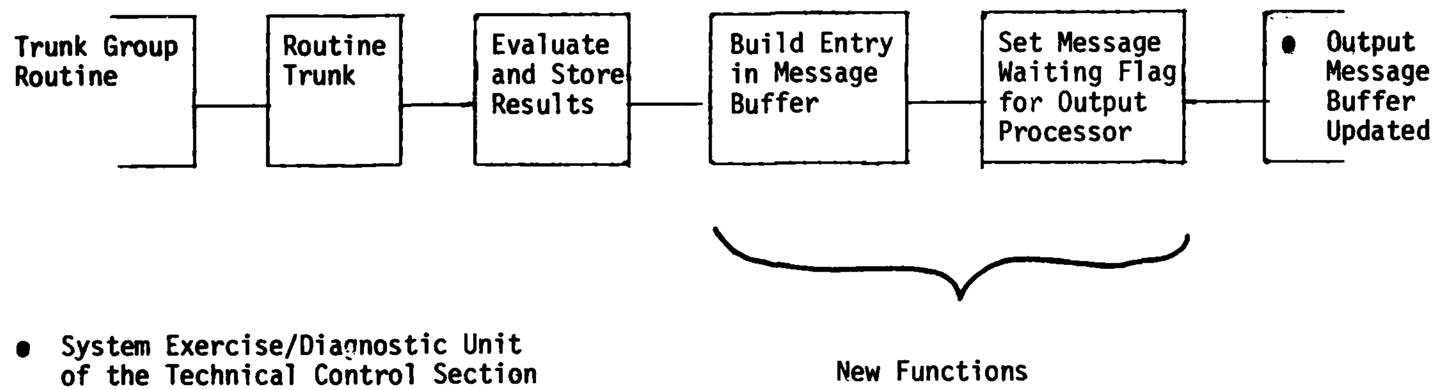


Figure 4-5. Formatting Message Rxx to Report Trunk Routining Failure

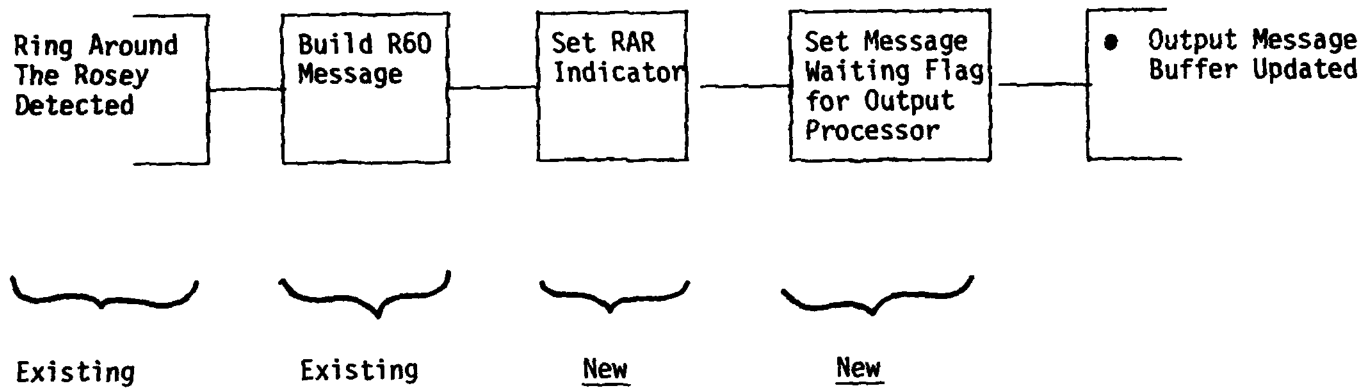


Figure 4-6. Notification of Detection of Ring Around Rosey Condition in TTC-39

/

4.1.4 Recommended Addition of the TTC-39 Report Consolidation Processor

The TTC-39 Report Consolidation Processor is required to:

- o Multiplex the 9 flows of ICD-004 reports from the TTC-39 switches onto a single telemetry link to the ACOC in ADCCP format.
- o Route directives from the ACOC to the proper SYSCON channel in ICD-004 format.

Figure 4-7 details the functions required of this implementation.

4.1.5 Recommended Modifications to DSCS

In DSCS, it is recommended that the software be modified so as to:

A. Report by exception up the DSCS hierarchy to ACOC.

B. Report status changes to the ATEC-CIS in ATEC format.

C. Maintain historical profile of effective isotopic radiated power (EIRP) and received signal strength (RSS) at all levels of the DSCS Control Segment (CS).

Figures 4-8 through 4-10 present the functional flows describing the required changes to the TCE and NCE software.

4.1.6 Recommended Modifications to ATEC

The changes required of ATEC are those necessary to:

- o Implement SB-3865 reporting to ACOC
- o Notation of DSCS exceptions within ATEC

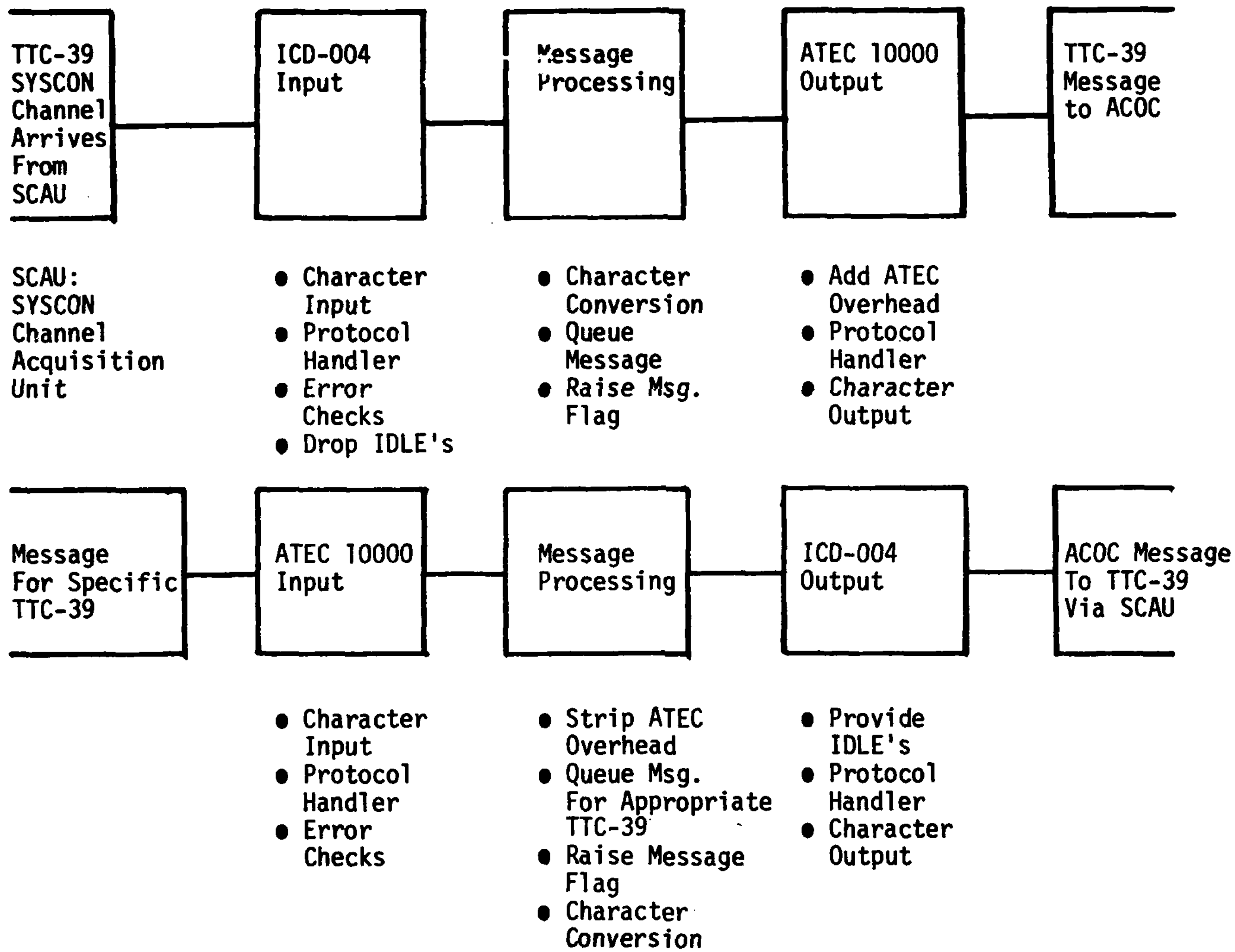


Figure 4-7 TTC-39 Report Consolidation Processor Functions

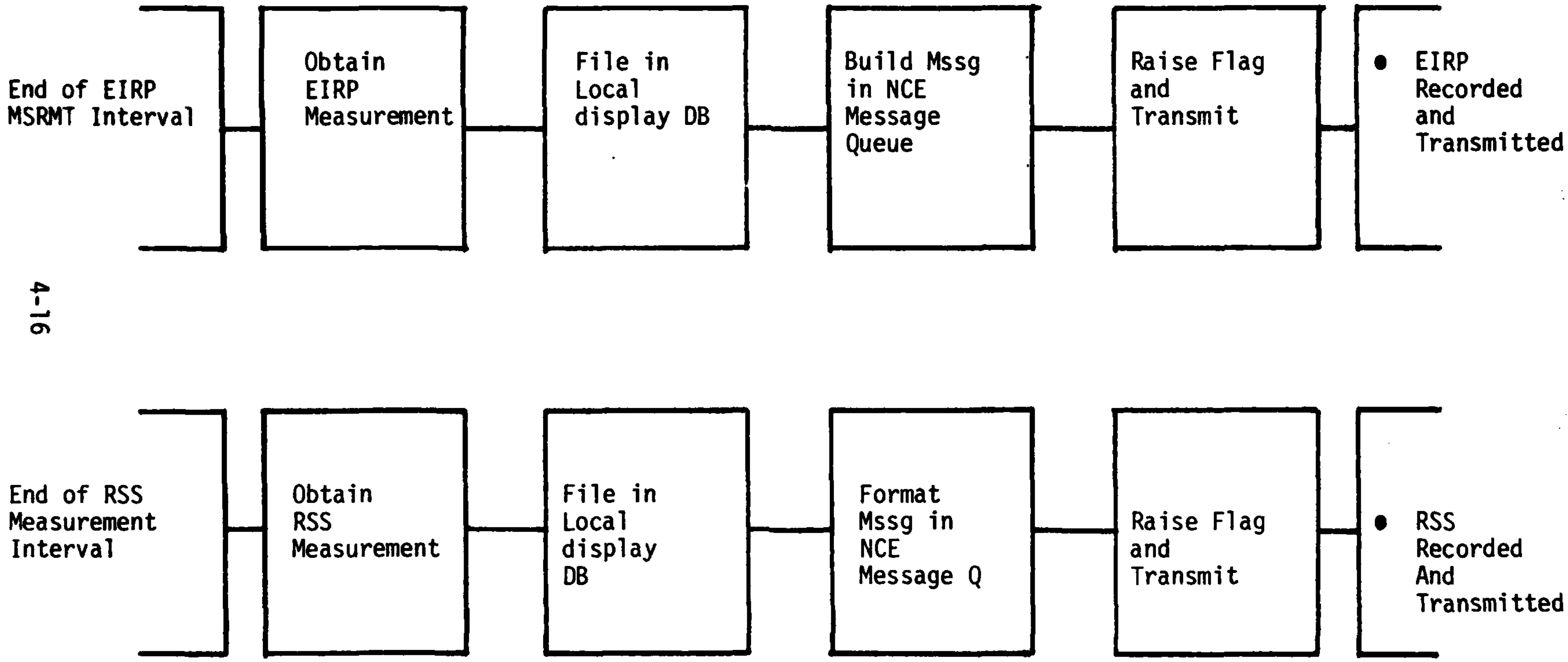


Figure 4-8. At the DSCS TCE EIRP and RSS Monitoring

Mux Alarm: Loss of sync, framing errors
Link Alarm: Result of monitoring of Power Margin, RSS, Pseudo BER

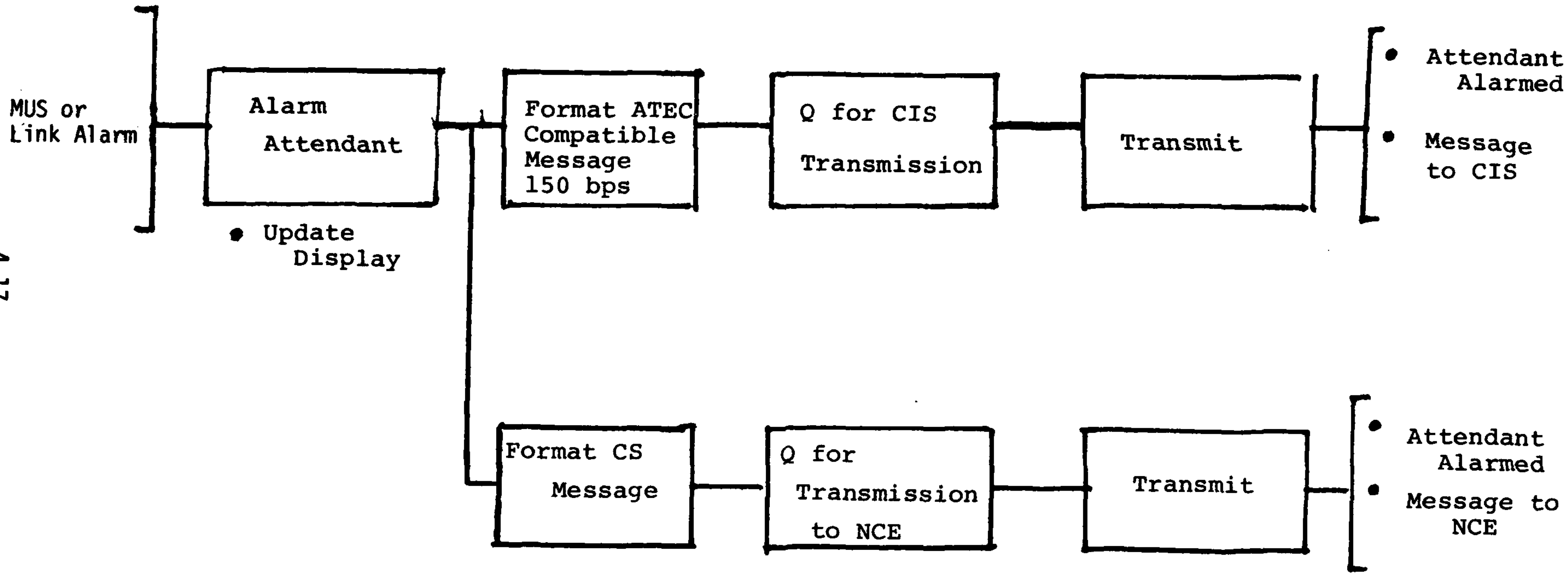


Figure 4-9. At the DSCS TCE: Exception Reporting

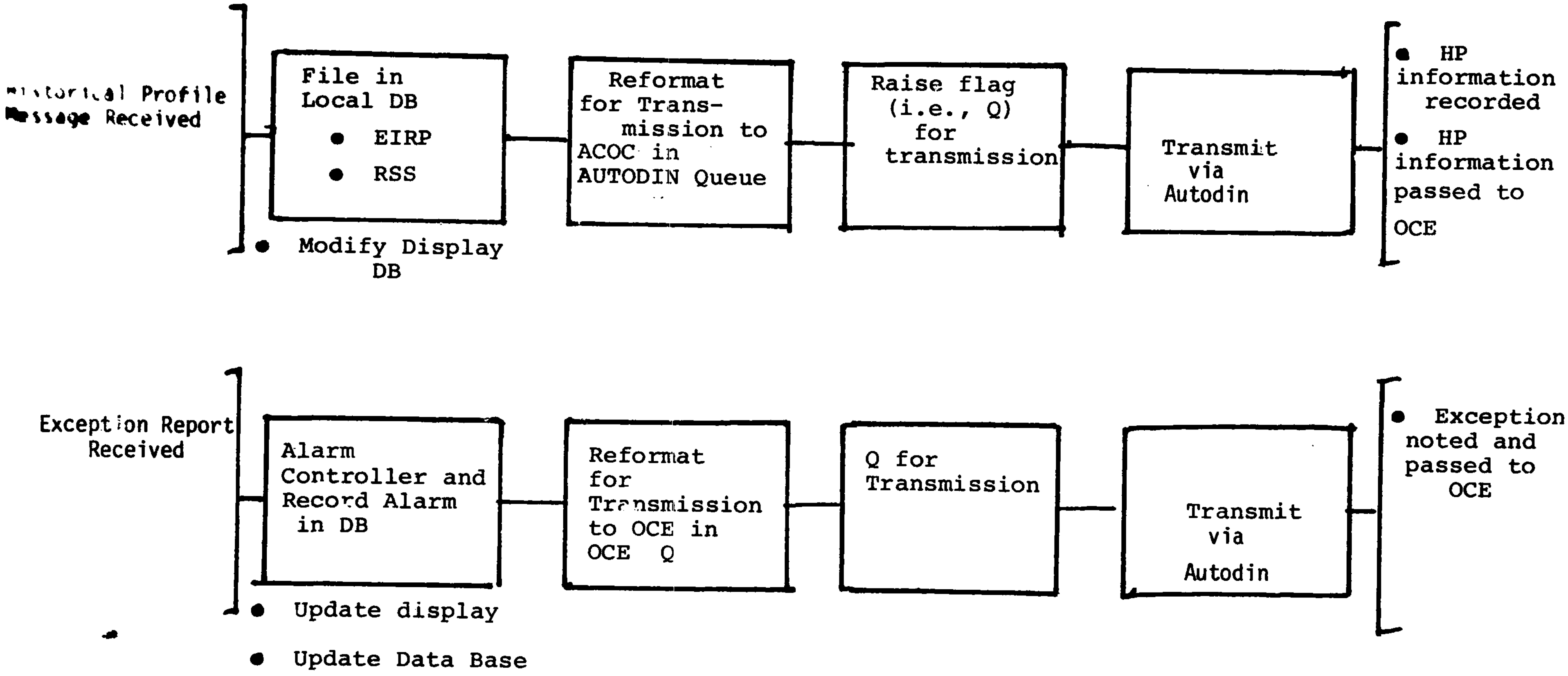


Figure 4-10: DSCS NCE Processing of HP and Exception Information

Each ATEC subsystem must be modified to work as a message switch node between ACOC and the individual ULSs.

To facilitate ATEC correlation of DSCS exceptions, the node must be able to correlate DSCS errors with ATEC detected failures and pass DSCS information onto the sector if it cannot accomplish the correlation itself.

Figures 4-11 to 4-13 detail the functions required of these features in the CIS, NCS and SCS.

4.1.7 Recommended Modifications to ACOC-WWOLS

Two classes of functions have been added at the ACOC.

1. Acquiring data from new sources:
   - The AUTOVON switches
   - The AUTODIN II Subnetwork Control Center
   - The ATEC system
   - The DSCS Control Segment
2. Processing the acquired data to detect and isolate stresses, maintain data bases, and provide displays in support of real-time control of AUTOVON, Network Connectivity, and overall control of the theatre.

The software functions have been defined as if they are implemented in a computer separate from the WWOLS. Table 4-2 summarizes the stimuli received by ACOC-WWOLS. The functional flows for the software

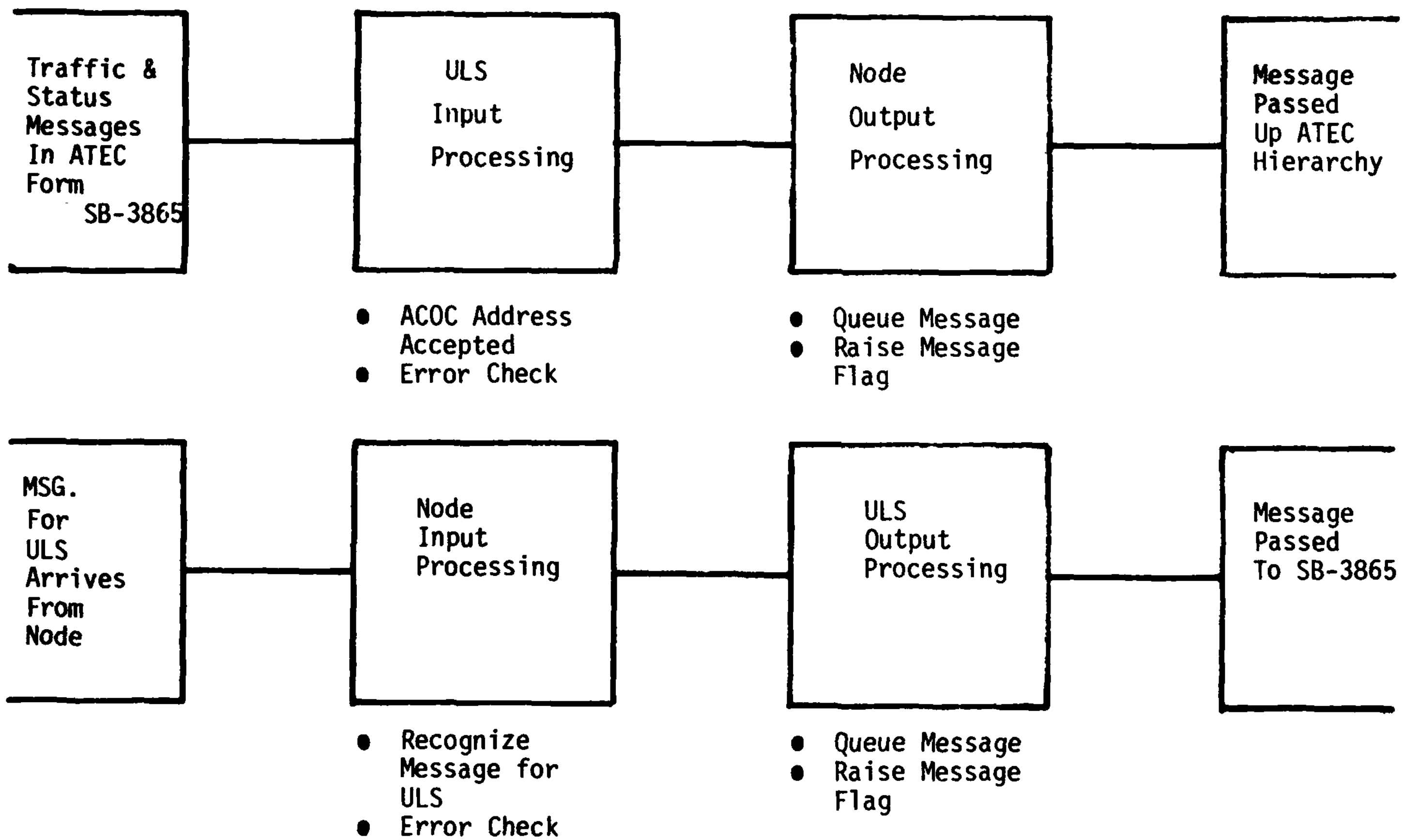


Figure 4-11. ATEC-CIS SB-3865 Report Processing

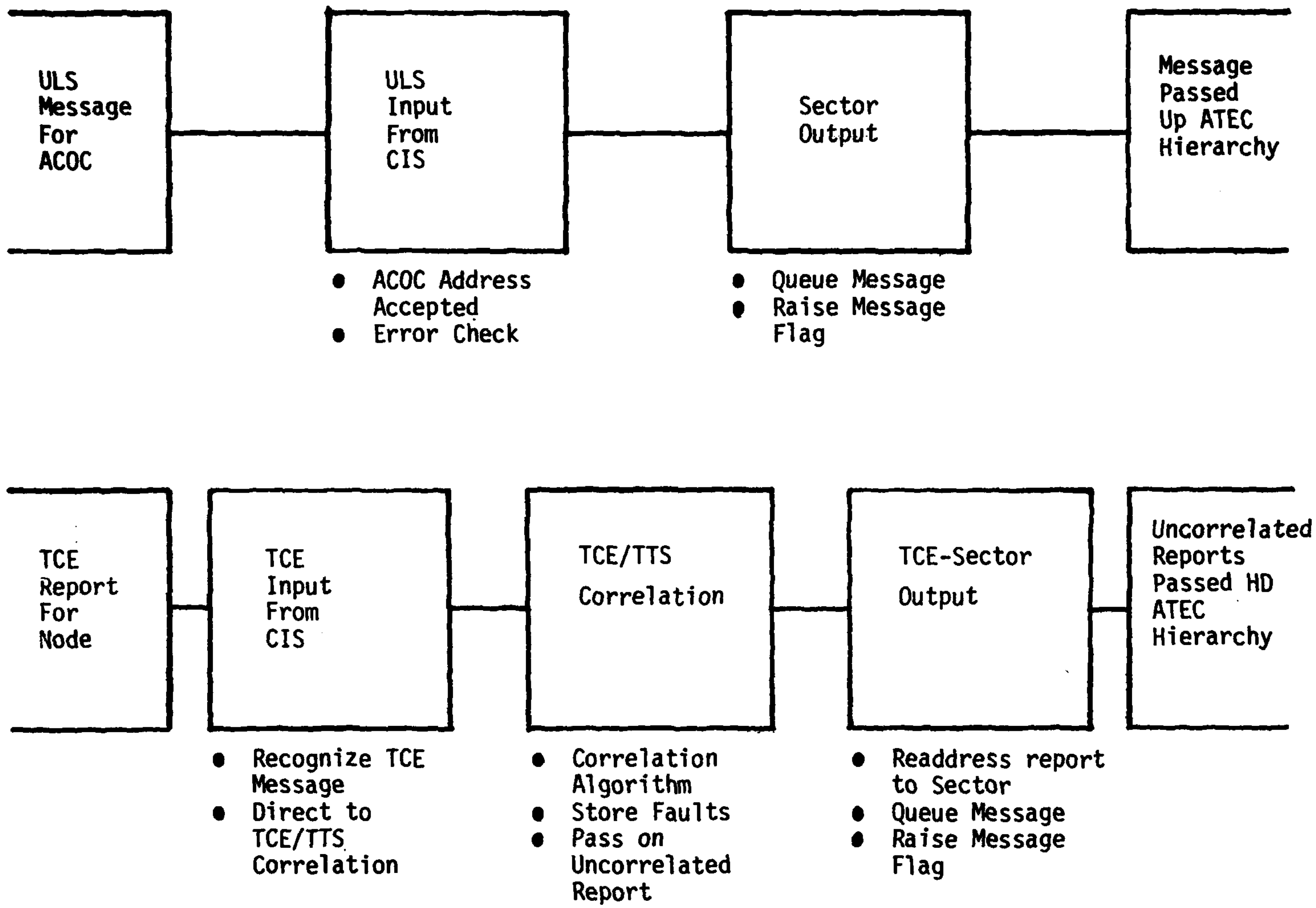


Figure 4-12. ATEC-NCS ULS and TCE Message Processing

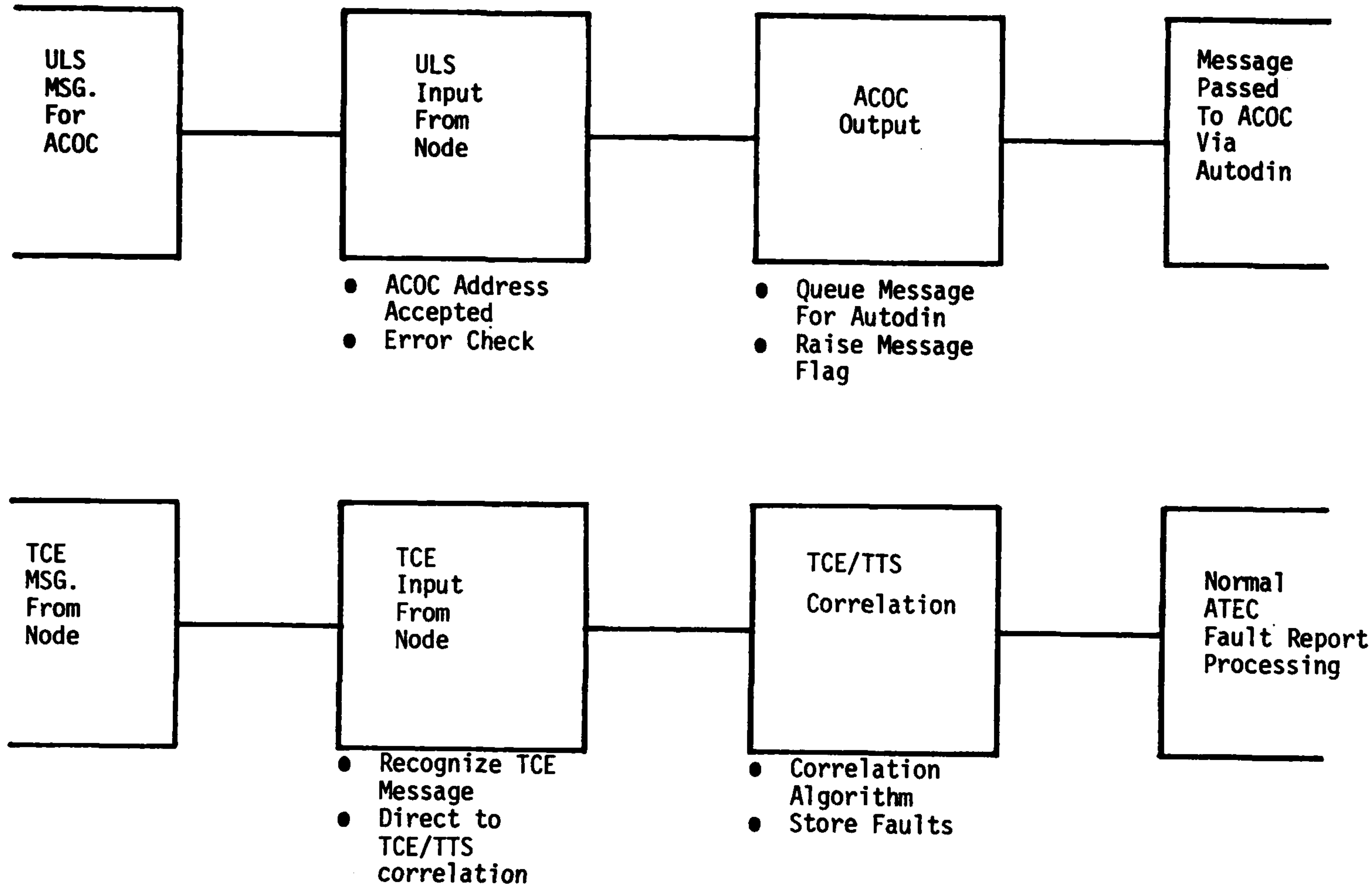


Figure 4-13. ATEC-SCS ULS and TCE Message Processing

TABLE 4-2. SOURCES OF INPUT TO THE ACOC-WWOLS SYSTEM

SOURCE	MEDIA	CATEGORY
1 ATEC SECTOR	AUTODIN	(A) TERRESTRIAL TRANSMISSION SYSTEM (TTS) EQUIPMENT STATUS
		(B) AUTOVON SWITCH (SB-3865) STATUS AND TRAFFIC PARAMETERS
		(C) TTS PMP DATA
2 SNCC	AUTODIN	(A) AUTODIN PACKET SWITCH NODE 55-1 FAILURE REPORT
3 NCE	AUTODIN	(A) DSCS EXCEPTION REPORTS
		(B) DSCS HISTORICAL PROFILE INFORMATION
4 THEATRE CONTROL FUNCTION	CRT	(A) CONTROL ACTION
		(B) DB QUERY
		(C) FREE FORM MESSAGE
5 NETWORK CONNECTIVITY CONTROL FUNCTION	CRT	(A) CONTROL ACTION
		(B) DB QUERY
		(C) FREE FORM MESSAGE
6 AUTOVON CONTROL FUNCTION	CRT	(A) CONTROL ACTION
		(B) DB QUERY
		(C) FREE FORM MESSAGE
7 ACOC	INTERNAL	(A) DERIVATION FROM EXTERNALLY PROVIDED DATA
		(B) DB UPDATE
8 TTC-39	DEDICATED LINE FROM TTC-39 REPORT CONSOLIDATION PROCESSOR	(A) STATUS AND TRAFFIC PARAMETERS

necessary to implement these modifications have been divided into four categories:

1. ACOC-WWOLS data interface control; Figures 4-18 and 4-19.
2. Theatre Control Function; Figures 4-20 to 4-25.
3. Network Connectivity Control Function; Figures 4-26 to 4-36.
4. AUTOVON Control Function; Figures 4-37 to 4-46.

All input to and output from the Control Functions is handled via I/O queues. The queue managers are accessed by both the Control Functions and the Electrical Interface managers to enable the transfer of information between I/O buffers and the applications software. The Electrical Interface managers (AUTODIN II and TTC-39 interfaces) control the transfer of information into and out of the ACOC-WWOLS complex itself. They move reports between the I/O buffers and the I/O queues to facilitate this transfer.

The functional flows for the Control Functions have been organized as follows. Each of these three functions has an input queue which is the gateway to most processing incidental to the function. The first chart for each control function examines the contents of the respective input queue and determines the appropriate next step. The possible responses are listed as the outputs of the "input message processing" chart for each function. The charts for each response then follow in the order listed. An overview of the functional interaction of the three control functions is presented in Figure 4-14.

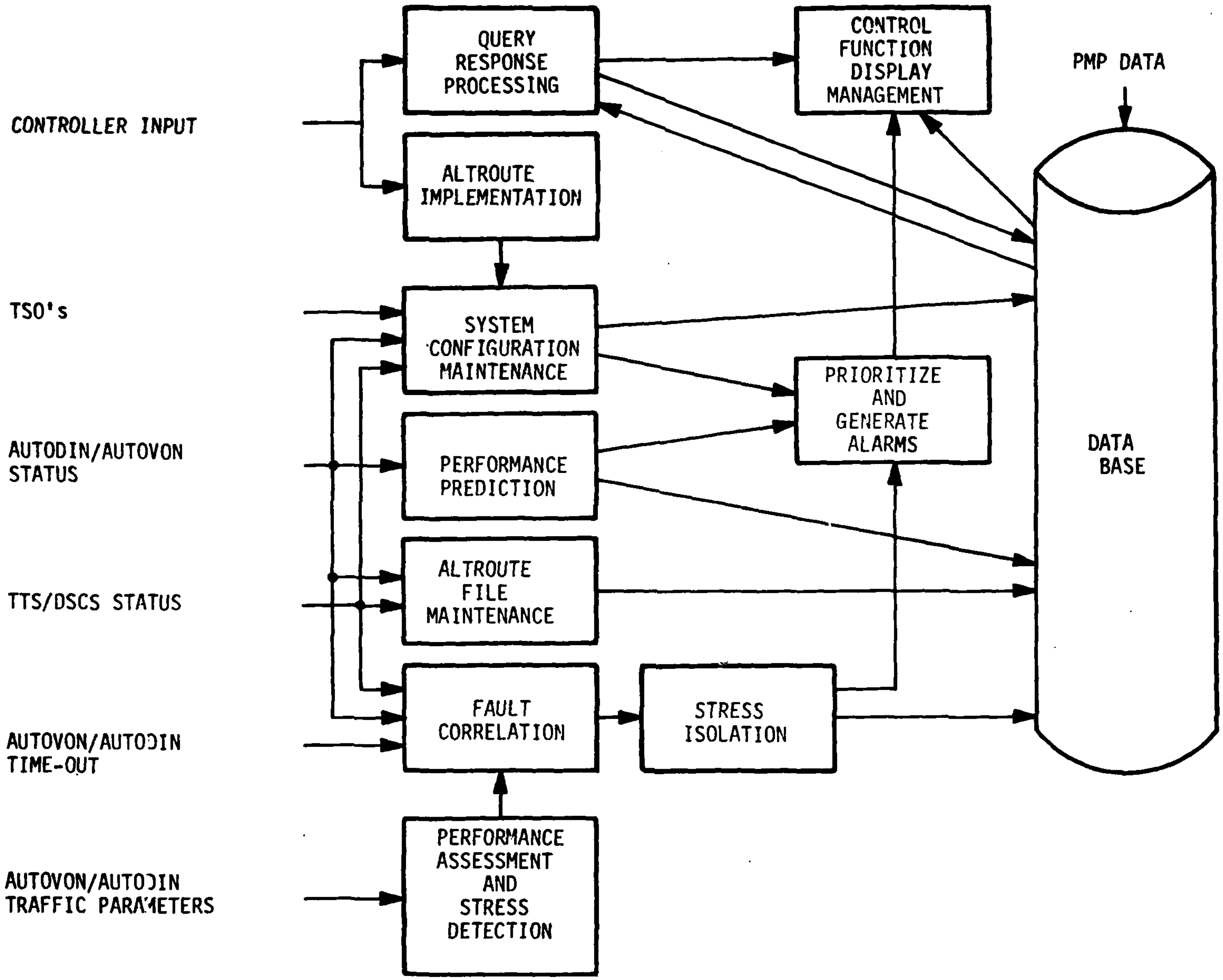


Figure 4-14. Functional Interaction of the Three Control Functions

Hierarchy Charts for Recommended Additions to ACOC-WWOLS

The hierarchy charts on the following pages (Figures 4-15 to 4-17) have been developed for each of the four categories of functional flows. One of the charts encompasses ACOC-WWOLS Interface Control and the Theatre Control Function. Separate charts have been provided for the AUTOVON Control and Network Connectivity Control Functions. The Control Function charts consist of seven levels of hierarchy.

1. The top level is the executive for the specific control/supervisory function.
2. The second level consists of the software responsible for administration of the acquisition, processing and interfacing of data.
3. The third level routines are the overhead functions making up each control function.
4. The fourth level routines are the specific functions of each general function.
5. The fifth level routines execute specific algorithms in support of the level 4 functions.
6. The sixth level routines are data base interface routines.
7. The seventh level is an off the shelf data base management system.

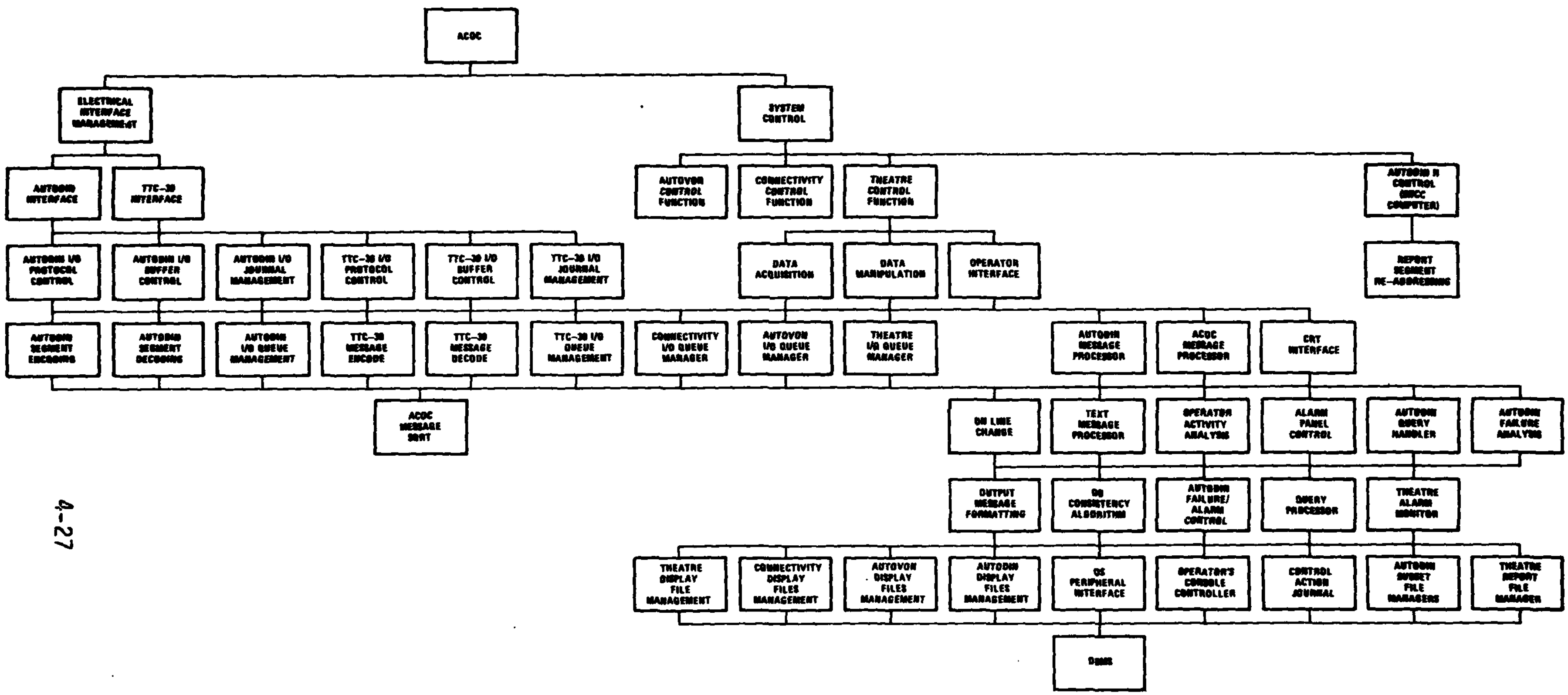


Figure 4-15. Electrical Interface Management and Theatre Control Functional Hierarchy Charts

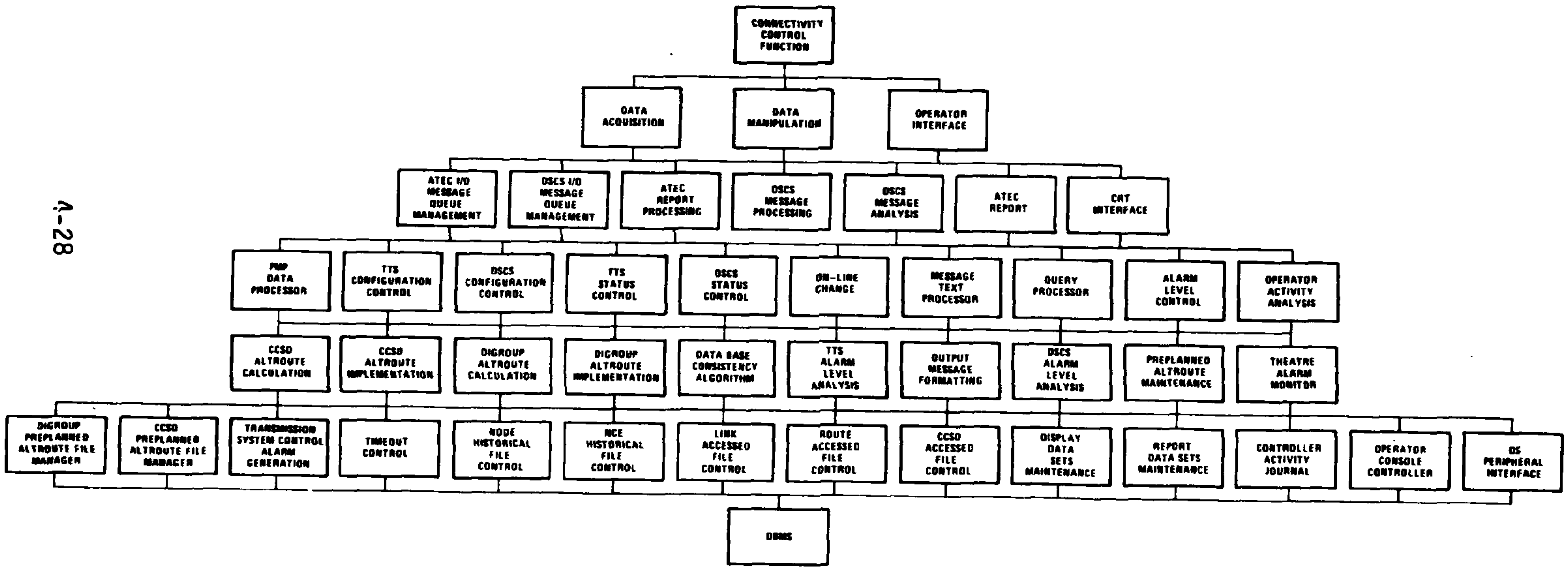


Figure 4-16. Network Connectivity Control Function Hierarchy Chart

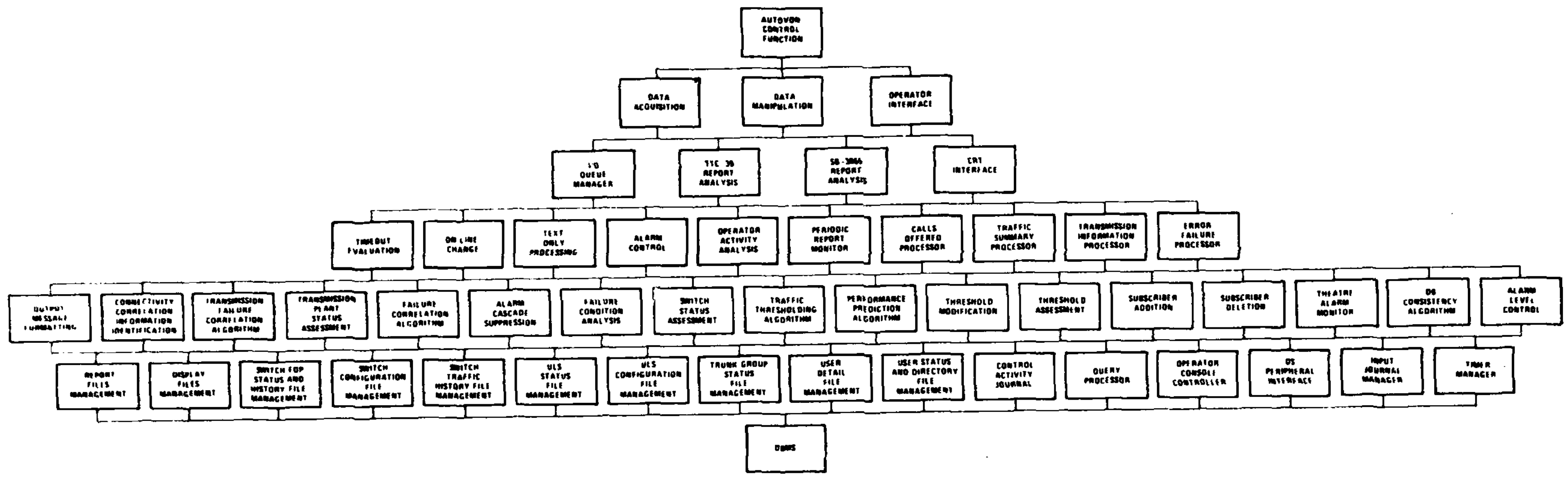


Figure 4-17. AUTOVON Control Function Hierarchy Chart

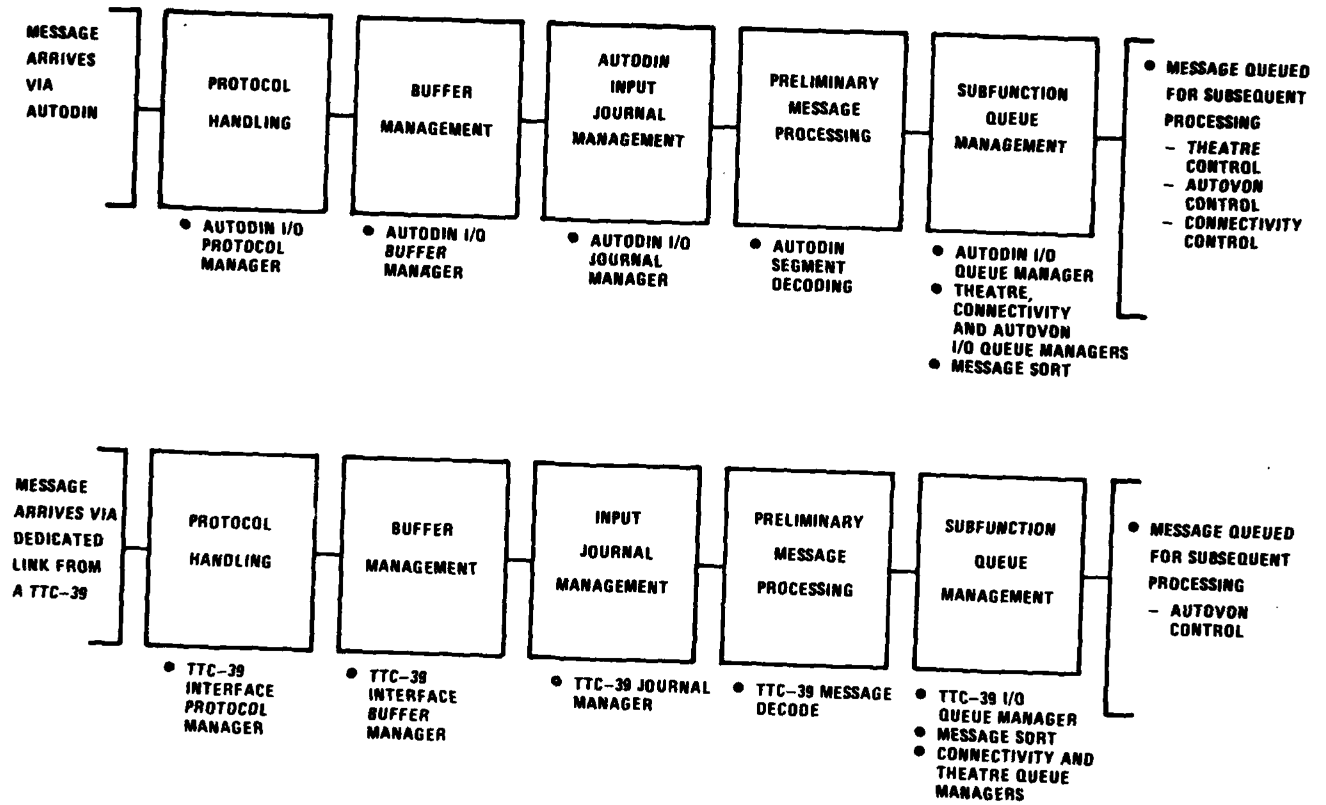


Figure 4-18. ACOC-WWOLS Data Input Interface Control

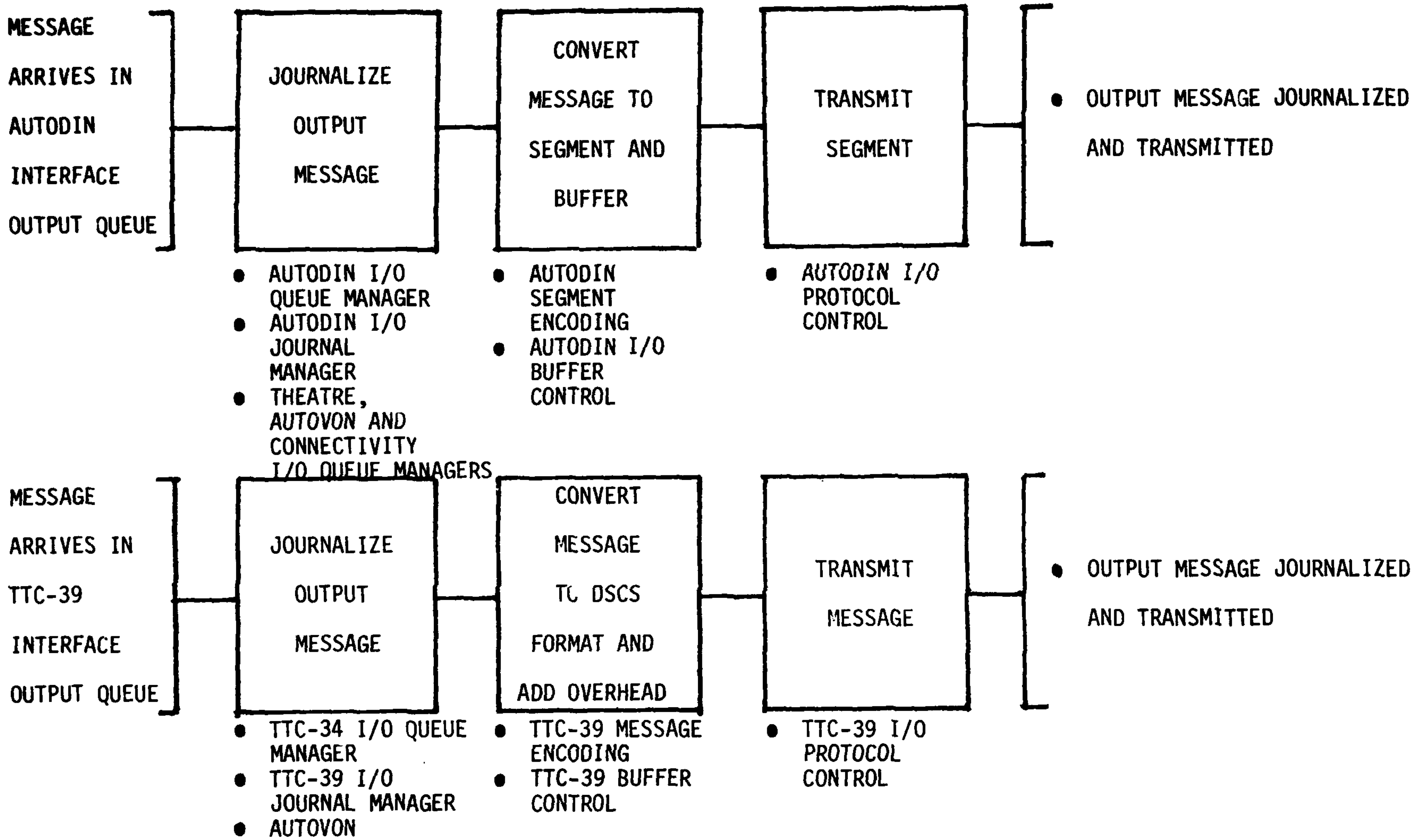


Figure 4-19. ACOC-WWOLS Data Output Interface Control

AD-A080 765 HONEYWELL SYSTEMS AND RESEARCH CENTER MINNEAPOLIS MN F/G 17/2
SYSTEM CONTROL FOR THE TRANSITIONAL DCS.(U)
DEC 78 F C ANNAND, M F BURKE, R K CROWE DCA100-78-C-0017
UNCLASSIFIED TR-2 SBIE-AD-E100 326 NL

3 OF 4
AD A
080765

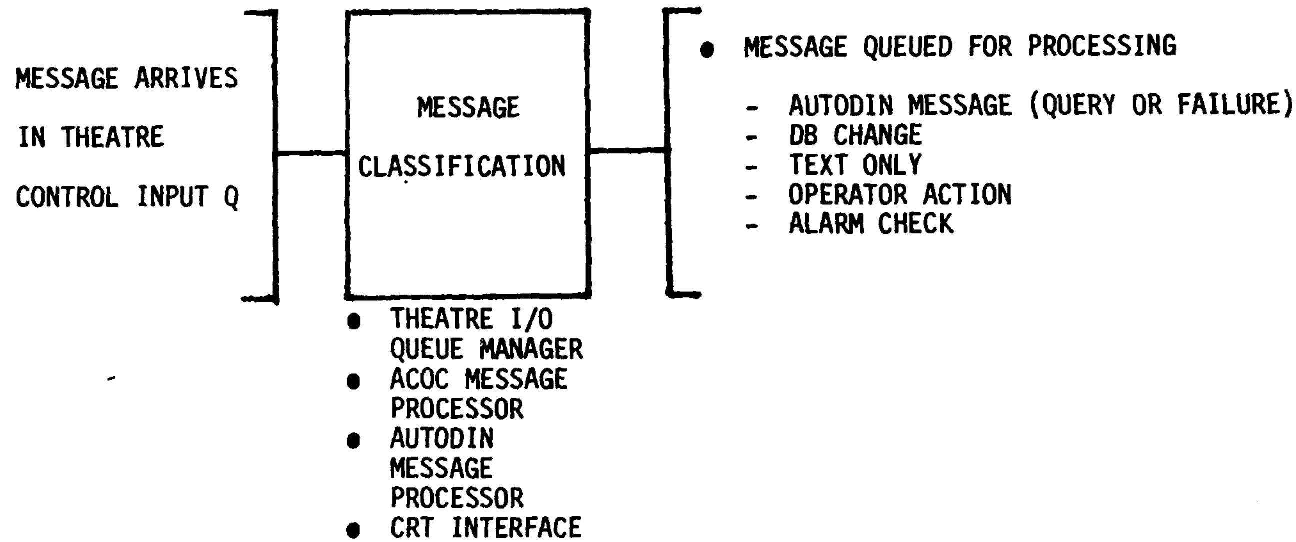


Figure 4-20. Theatre Control Input Message Processing

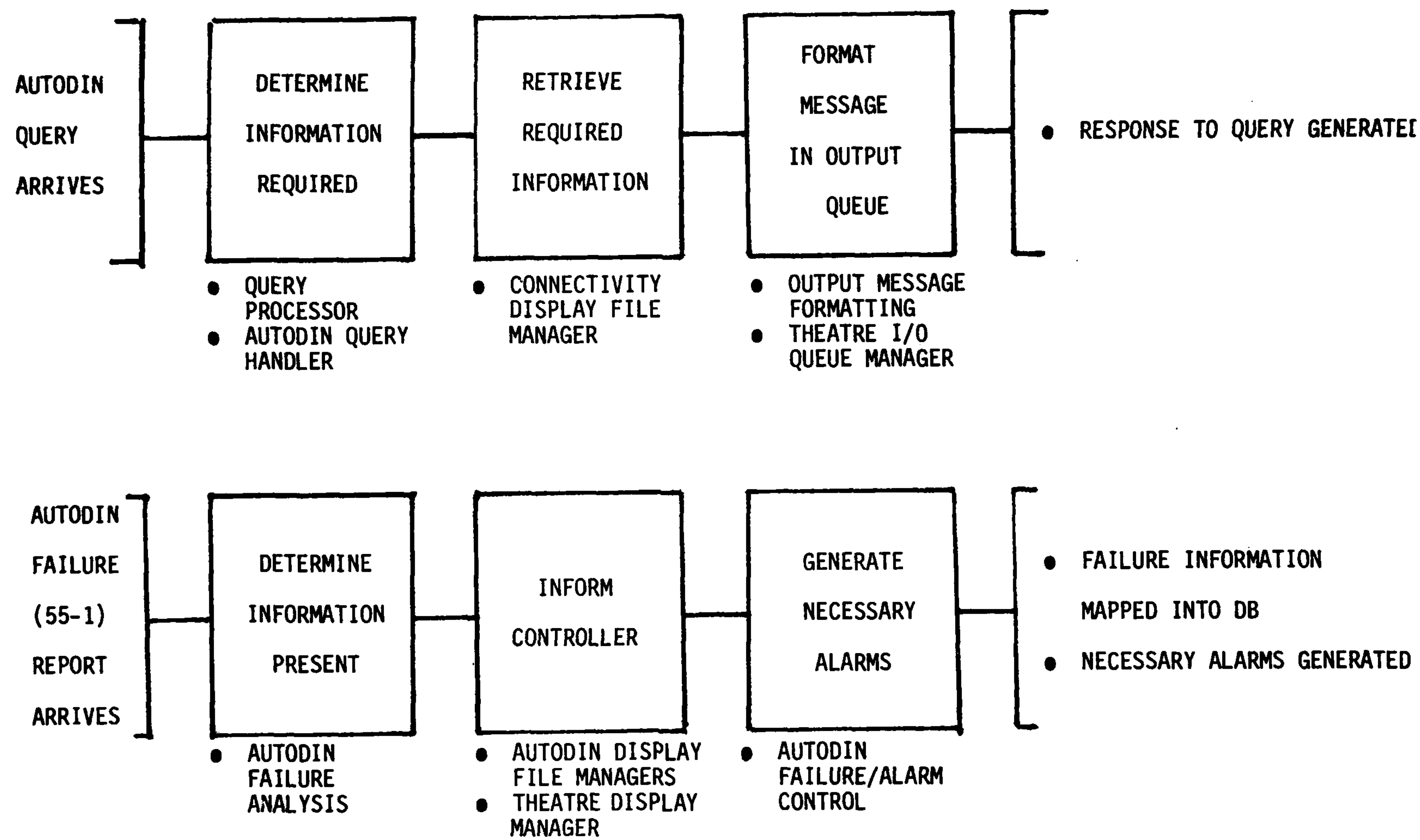


Figure 4-21. Theatre Control AUTODIN Message Processing

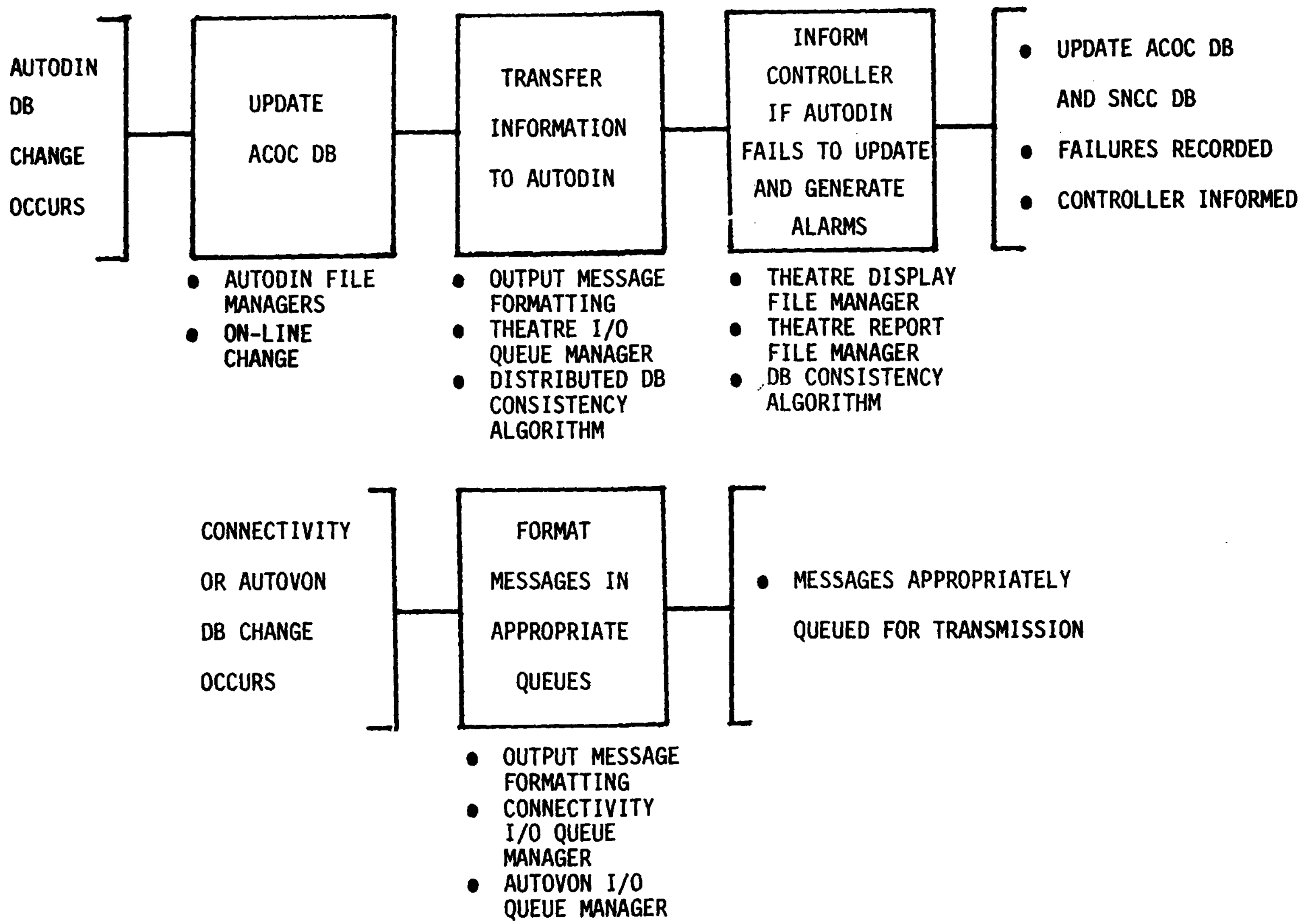


Figure 4-22. Theatre Control DB Change Processing

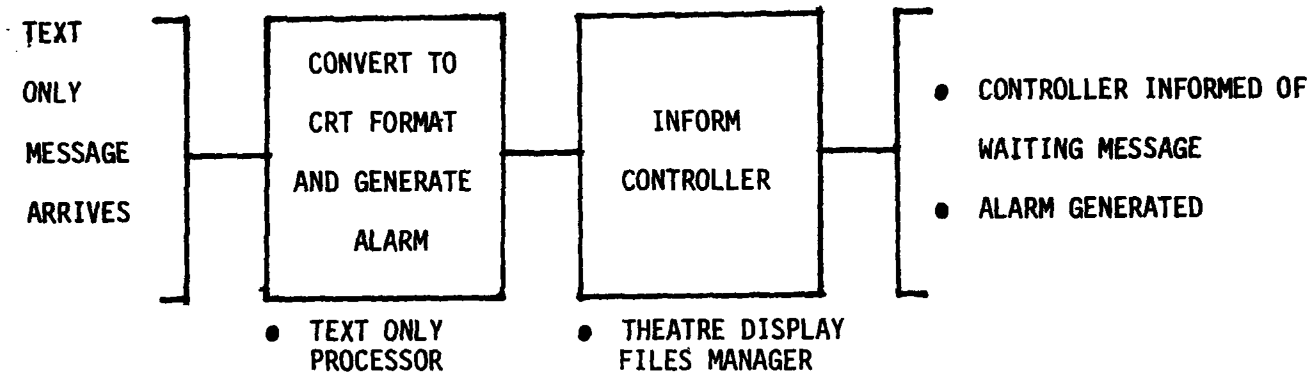


Figure 4-23. Theatre Control Text Only Message Processing

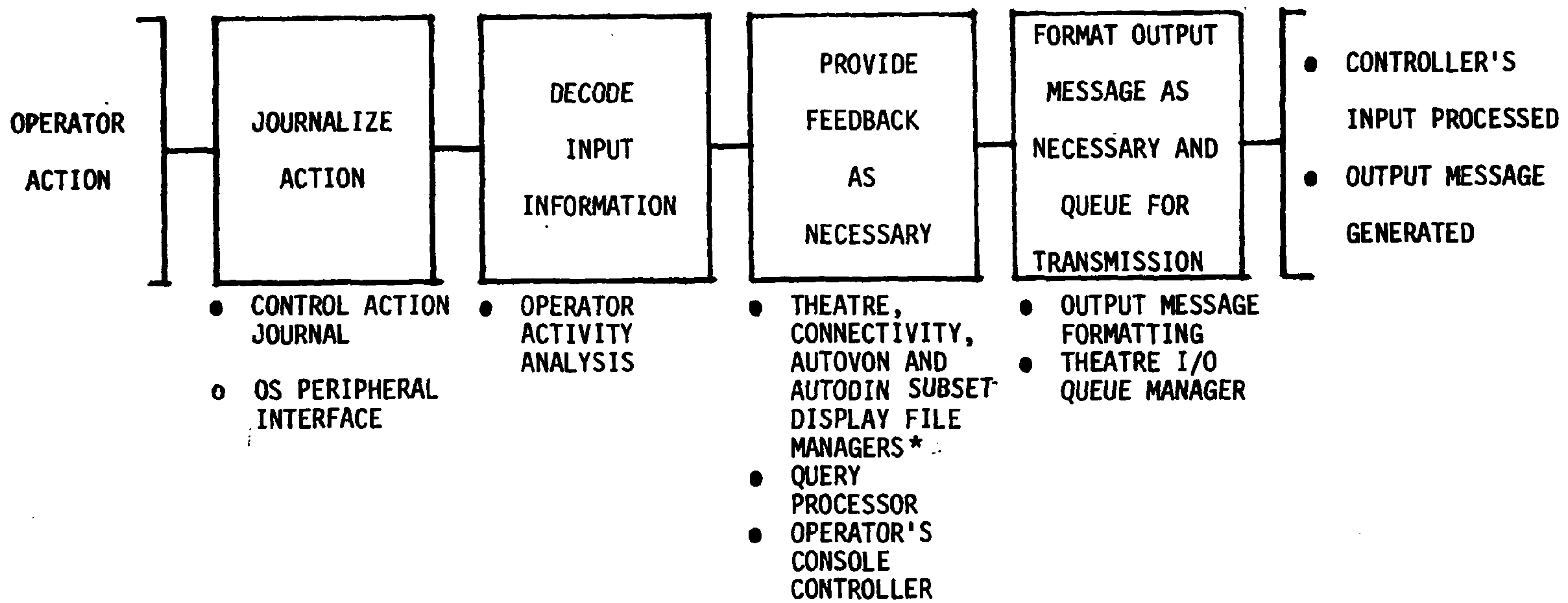


Figure 4-24. Theatre Control Operator Action

*Note: Because AUTODIN control is administered by a distinct Computer facility (the SNCC), an AUTODIN display subset is required to support the theatre Control Function.

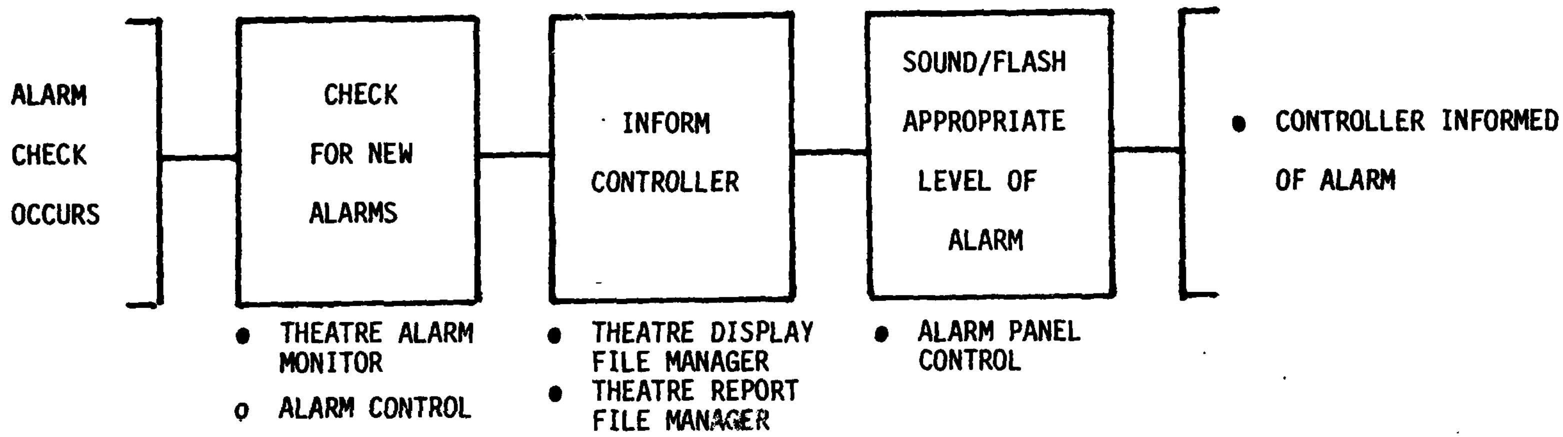
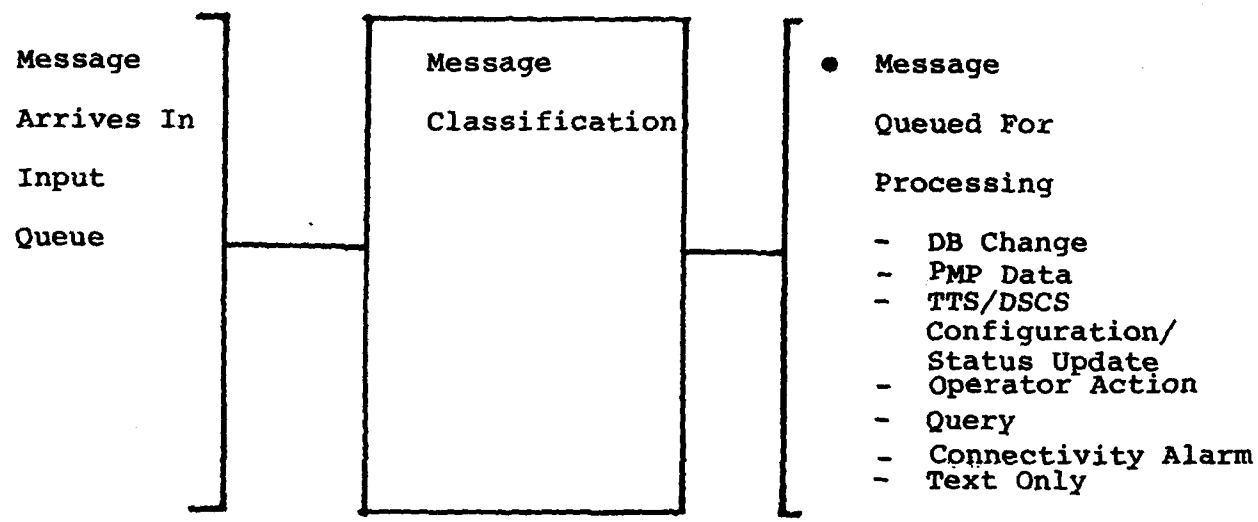


Figure 4-25. Theatre Control Alarm Processing



- ATEC I/O Message Queue Management
- DSCS I/O Message Queue Management
- ATEC Report Processing
- DSCS Message Processing
- ATEC Report Analysis
- DSCS Message Analysis
- CRT Interface

Note: There should be a decode routine for each Report/Message which subsequently calls or queues the necessary service routines.

Figure 4-26. Connectivity Control Input Message Processing

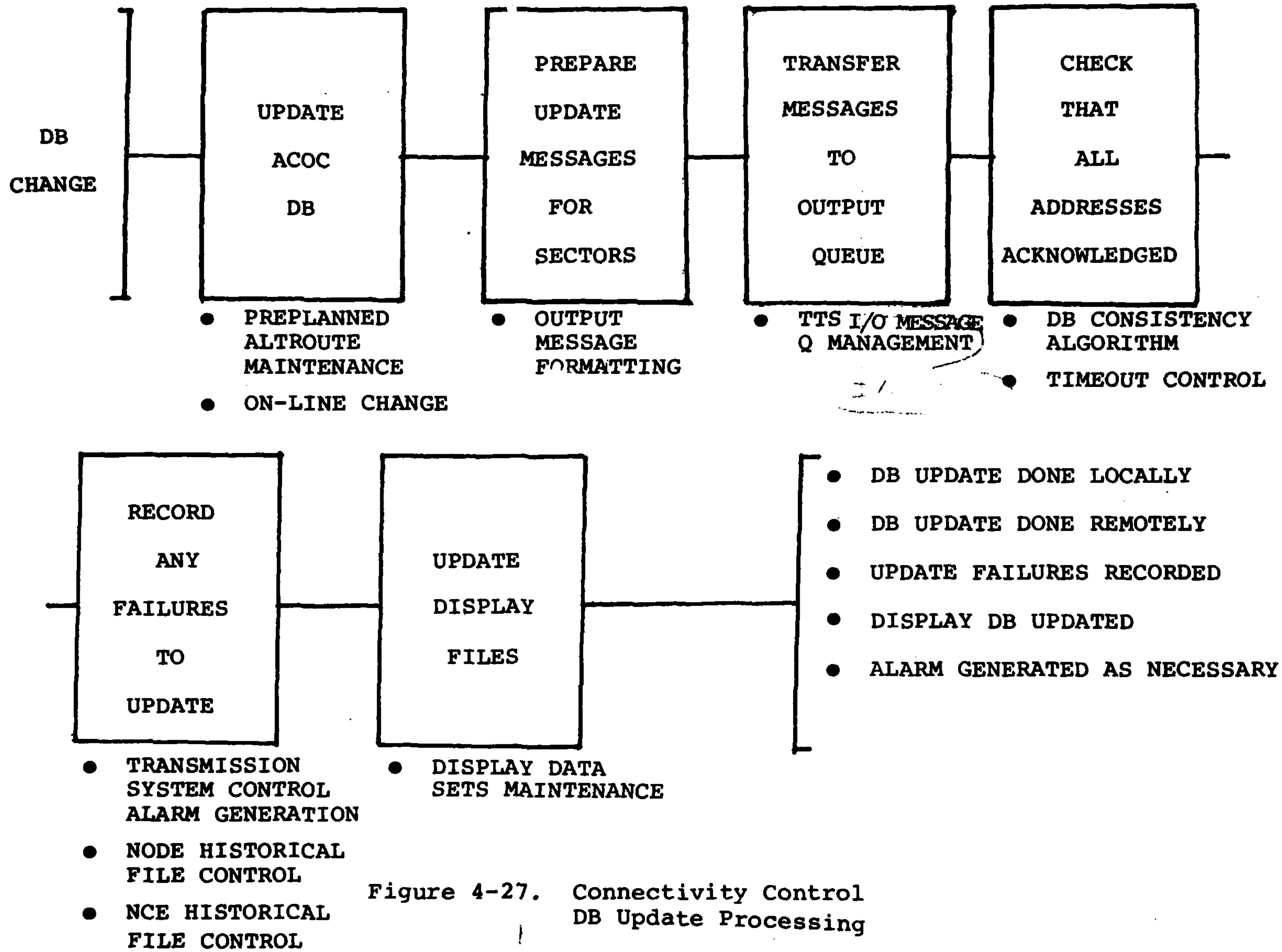


Figure 4-27. Connectivity Control DB Update Processing

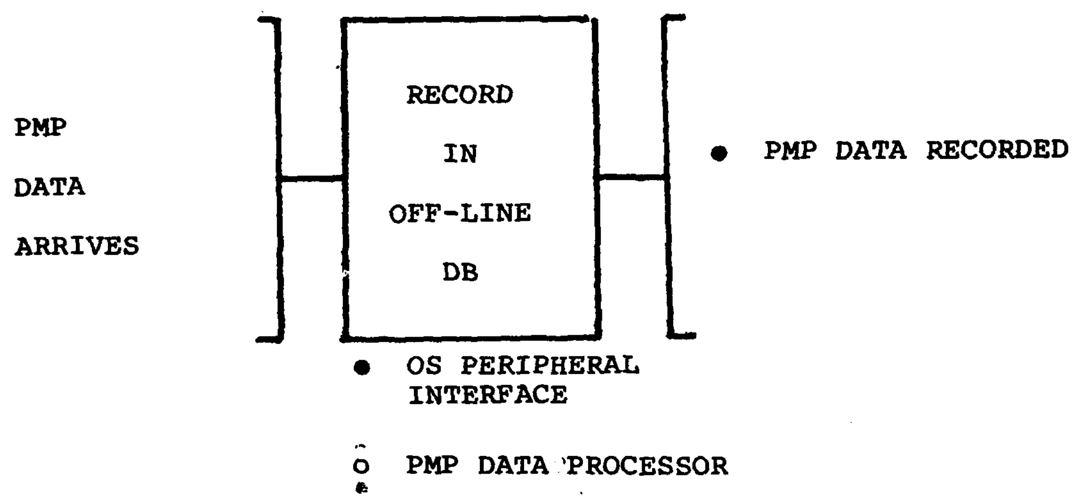
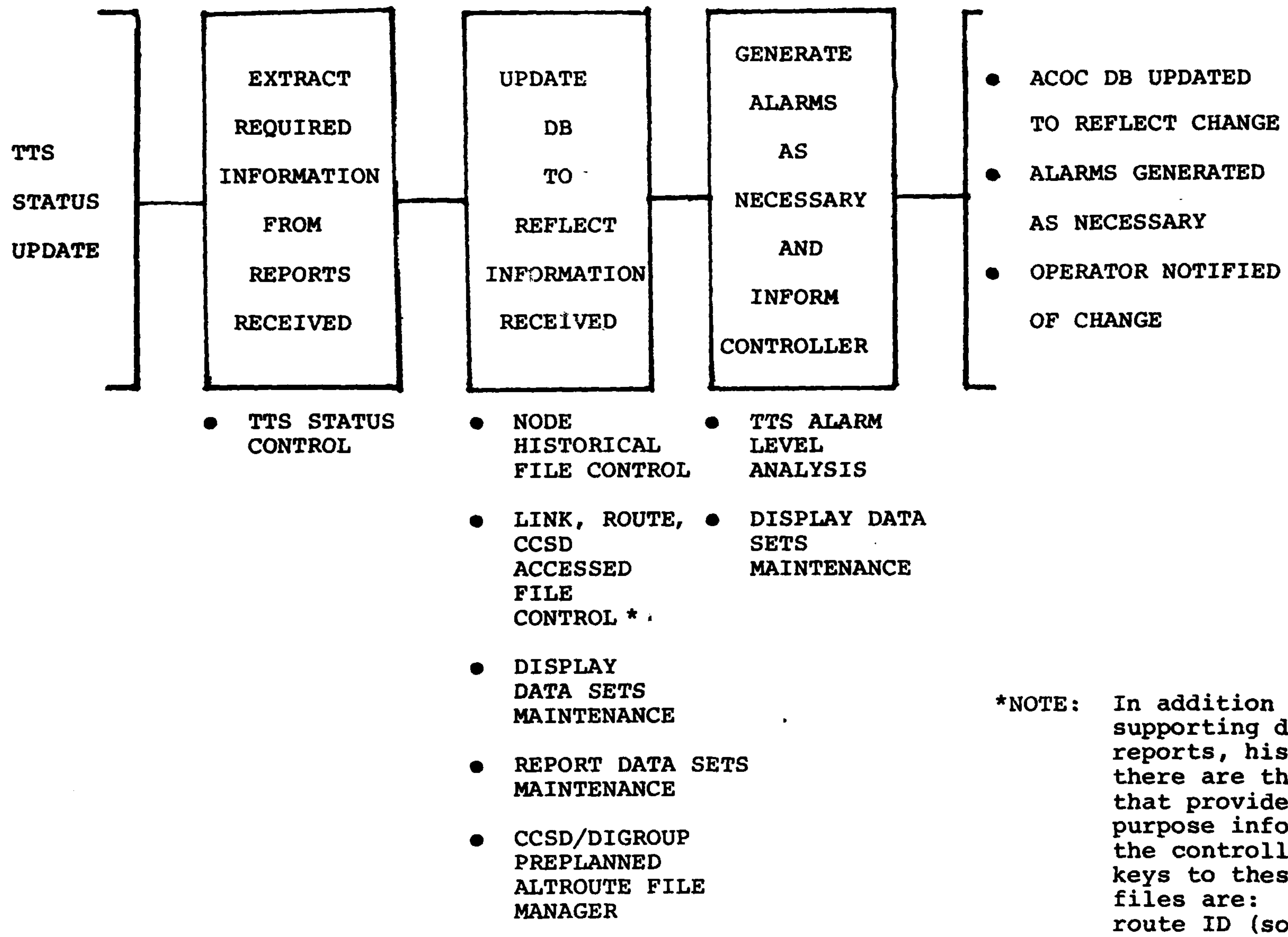
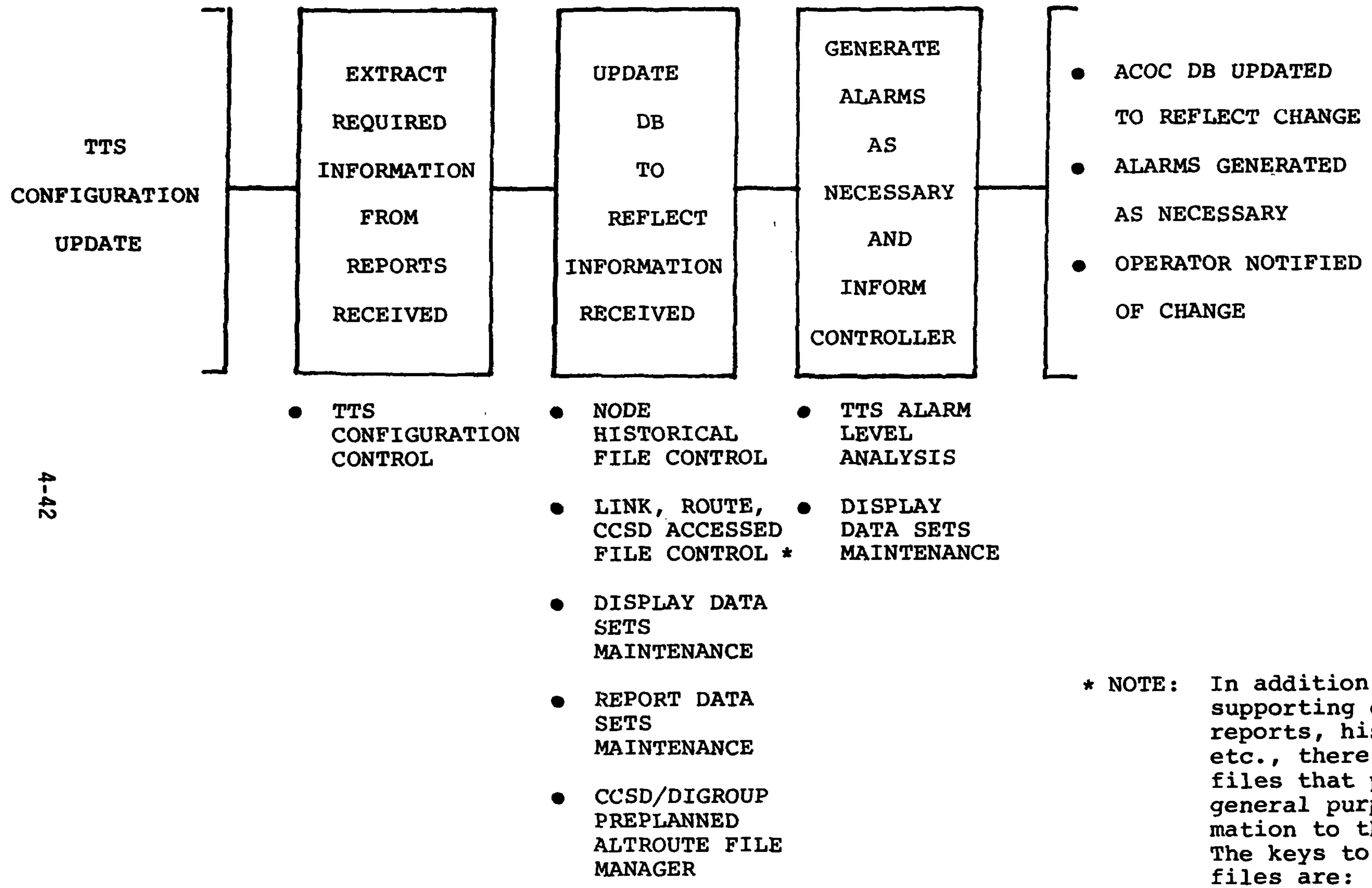


Figure 4-28. Connectivity Control PMP Data Storage



*NOTE: In addition to files supporting displays, reports, histories, etc. there are three files that provide general purpose information to the controller. The keys to these three files are: link ID, route ID (source/destination) and CCSD Number.

Figure 4-29. Connectivity Control TTS Status Update Processing.



* NOTE: In addition to files supporting displays, reports, histories, etc., there are three files that provide general purpose information to the controller. The keys to these three files are: link ID, route ID (source/destination) and CCSD Number.

Figure 4-30. Connectivity Control TTS Configuration Update Processing

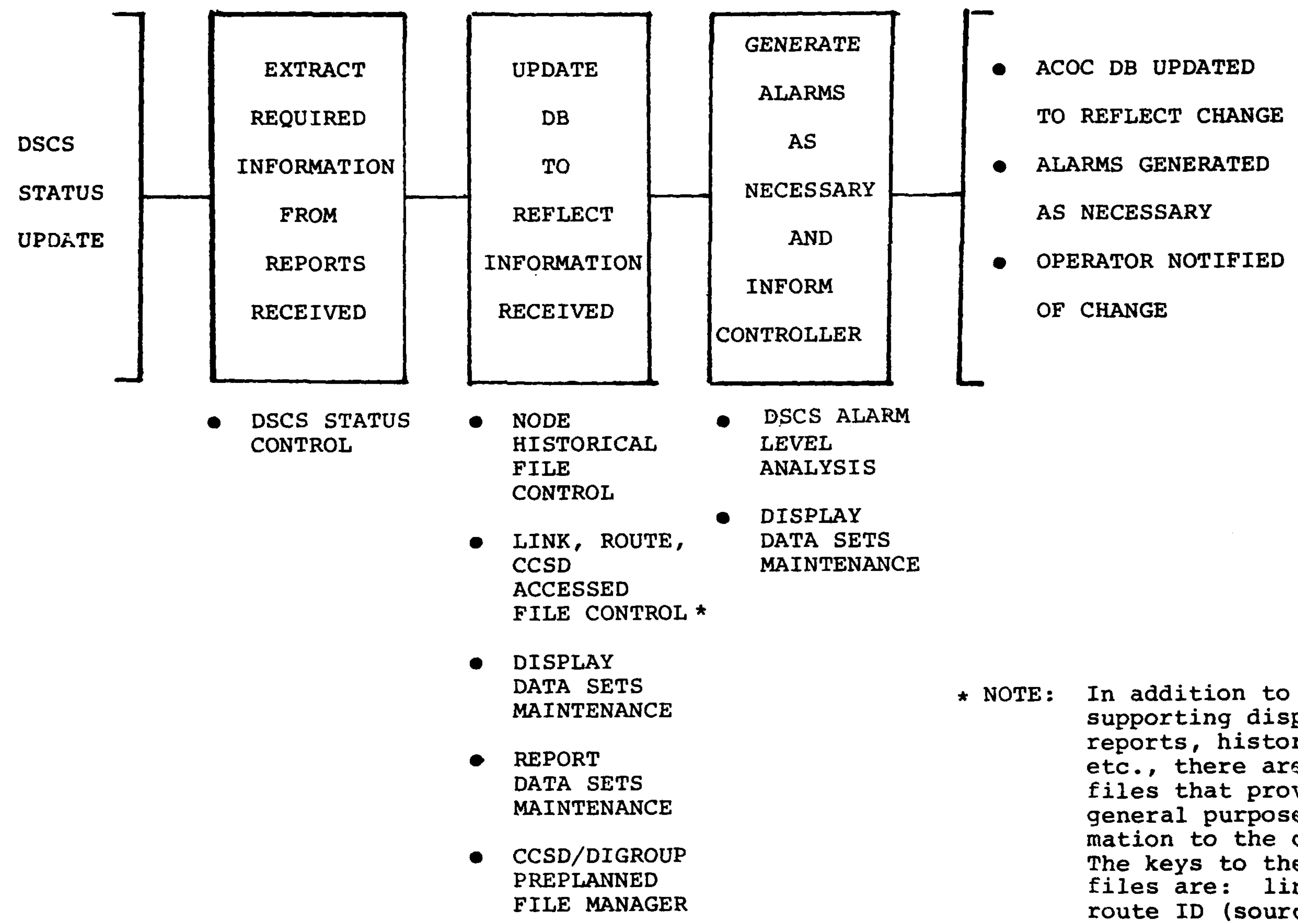
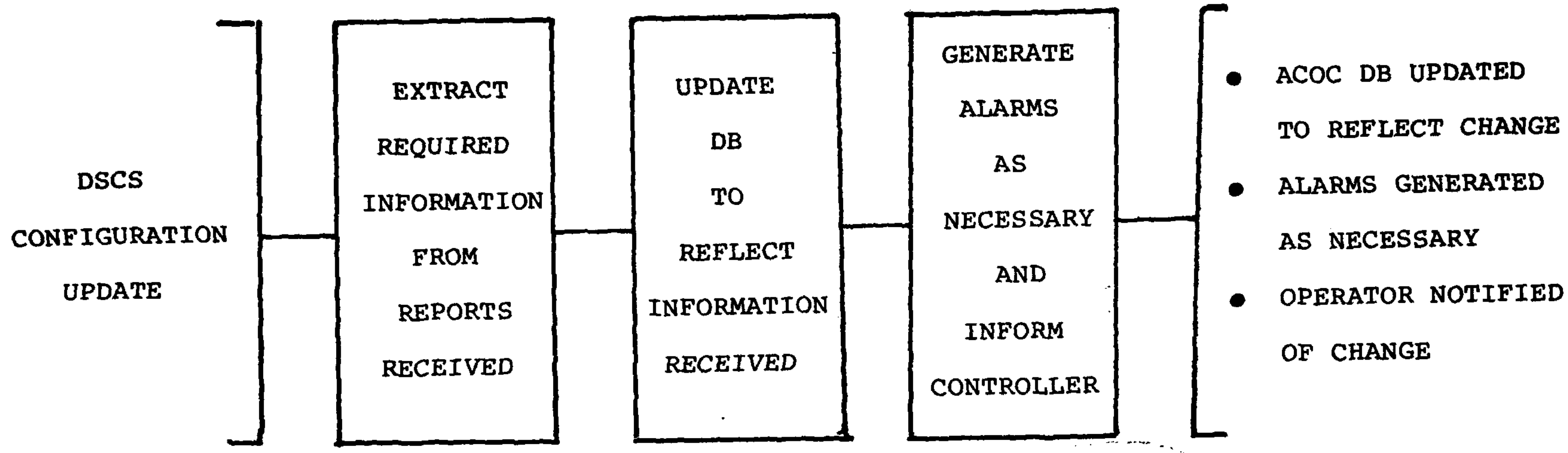


Figure 4-31. Connectivity Control DSCS Status Update Processing

* NOTE: In addition to files supporting displays, reports, histories, etc., there are three files that provide general purpose information to the controller. The keys to these three files are: link ID, route ID (source/destination) and CCSD Number.



- DSCS CONFIGURATION CONTROL

- NODE HISTORICAL FILE CONTROL
- LINK, ROUTE, CCSD ACCESSED FILE CONTROL *
- DISPLAY DATA SETS MAINTENANCE
- REPORT DATA SETS MAINTENANCE
- CCSD/DIGROUP PREPLANNED ALTROUTE FILE MANAGER

- DSCS ALARM LEVEL ANALYSIS
- DISPLAY DATA SETS MAINTENANCE

Figure 4-32. Connectivity Control DSCS Configuration Update Processing

* NOTE: In addition to files supporting displays, reports, histories, etc., there are three files that provide general purpose information to the controller. The keys to these three files: link ID, route ID (source/destination) and CCSD Number.

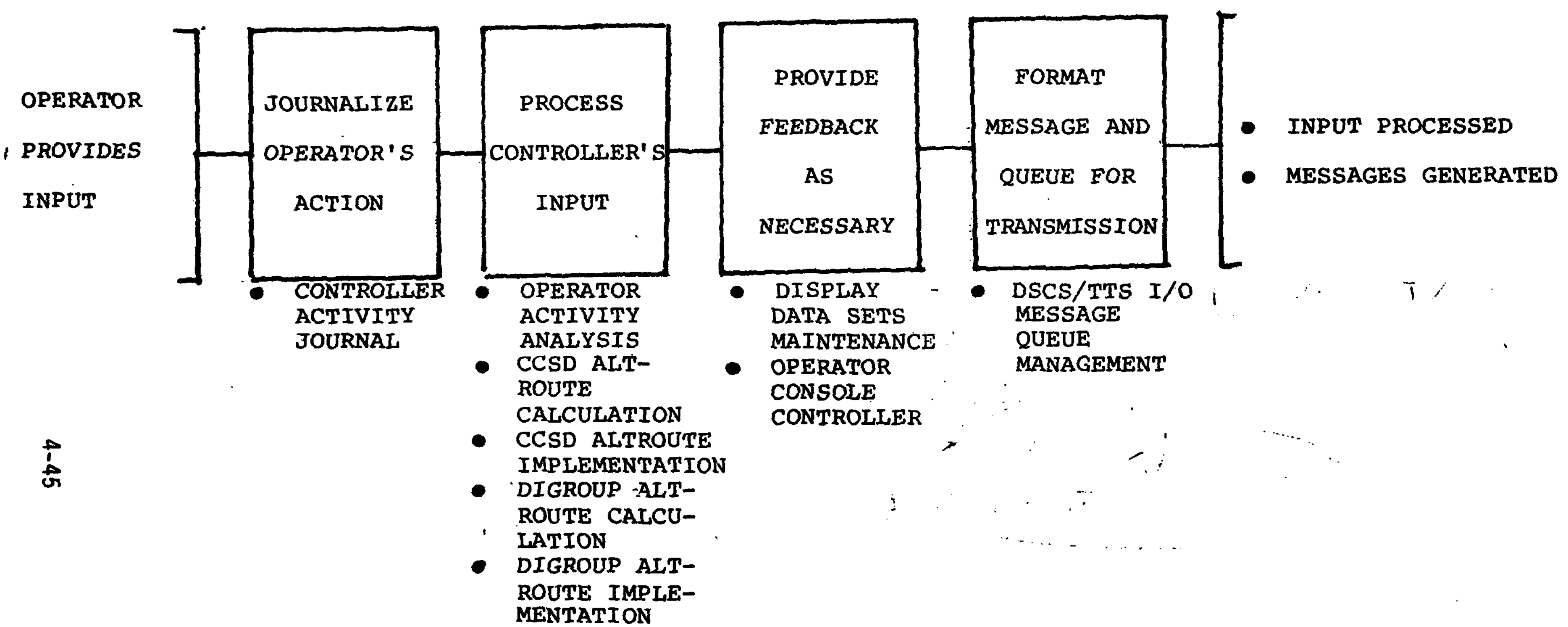


Figure 4-33. Connectivity Control Operator Action

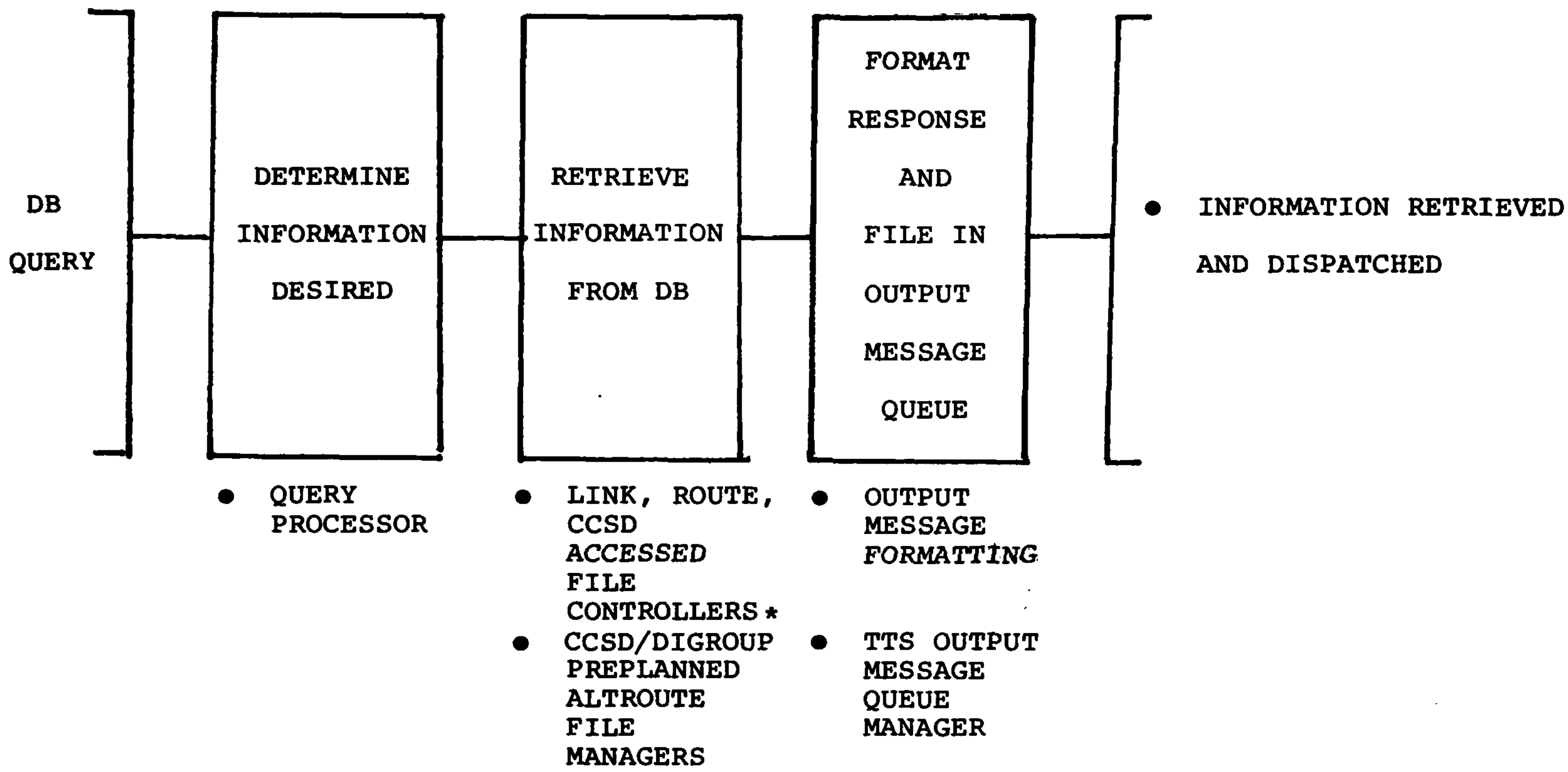


Figure 4-34. Connectivity Control DB Query Processing

*NOTE: In addition to files supporting displays, reports, histories, etc., there are three files that provide general purpose information to teh controller. The keys to these three files are: link ID, route ID (source/destination) and CCSD Number.

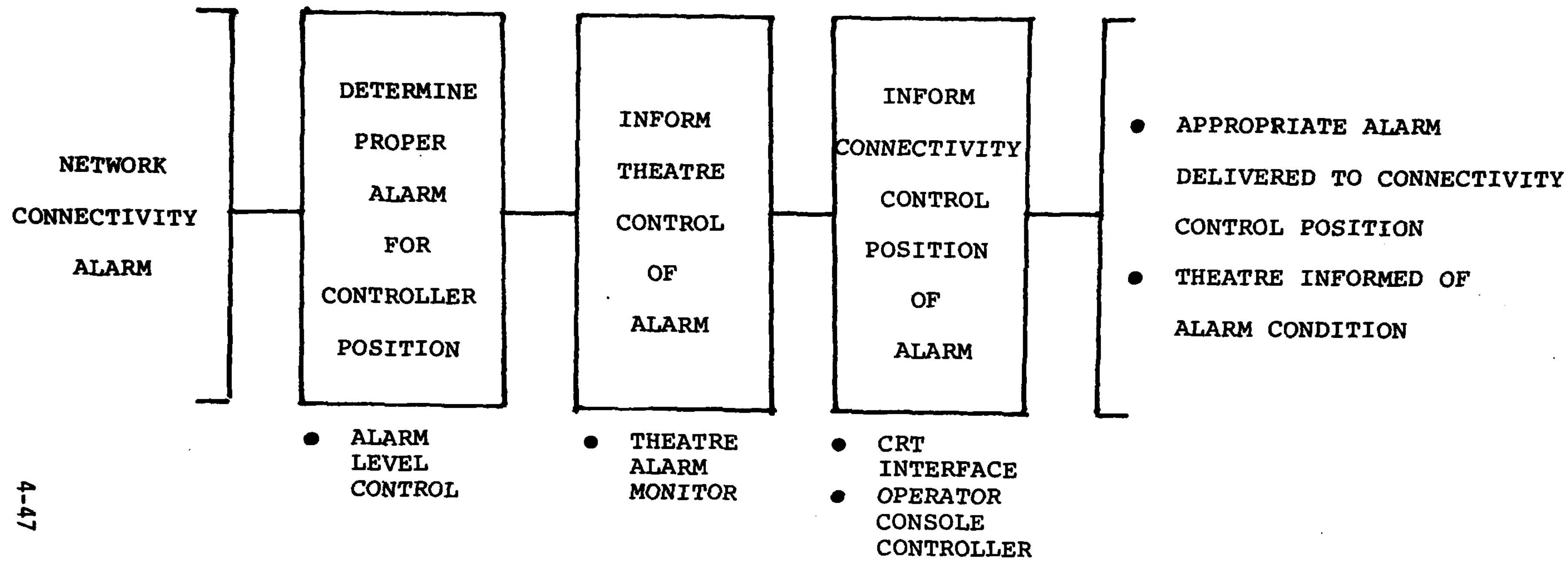


Figure 4-35. Connectivity Control Alarm Processing

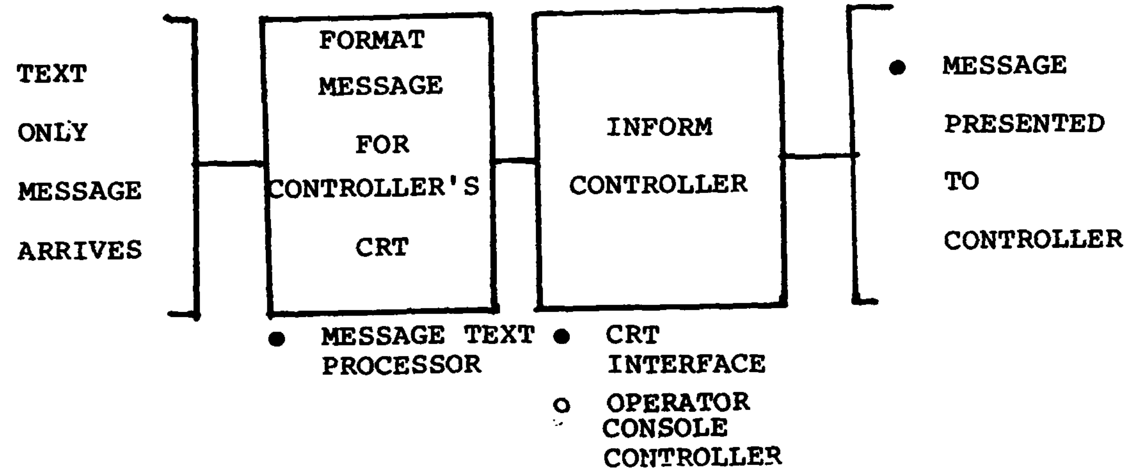


Figure 4-36. Connectivity Control Text Only Message Processing

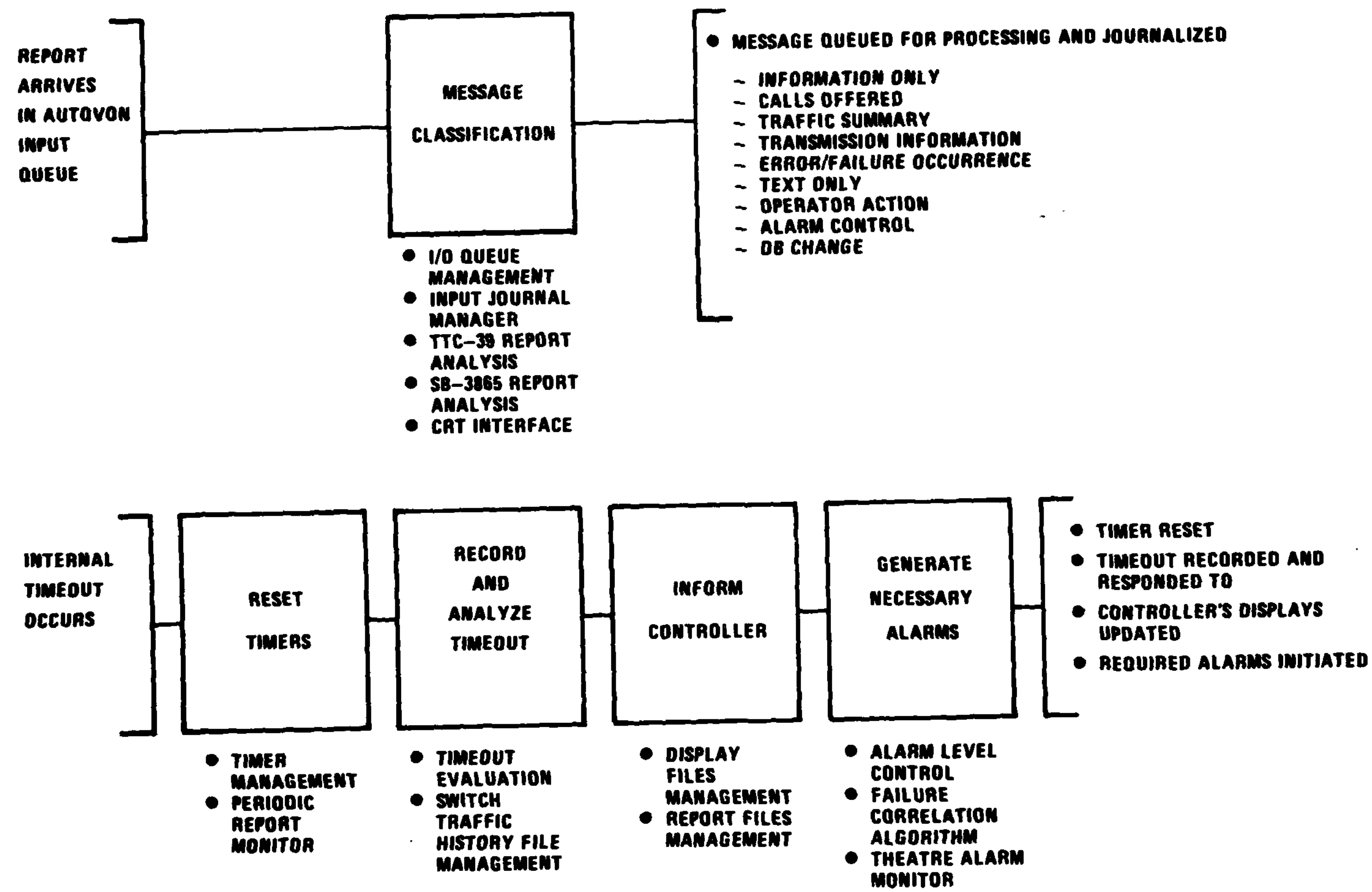


Figure 4-37. AUTOVON Control Input and Timeout Processing

INFORMATION ONLY REPORT ARRIVES (R68, R70, R72, R73)

THESE REPORTS REQUIRE NO FURTHER PROCESSING BEYOND AUTOVON CONTROL FUNCTION LEVEL JOURNALIZATION

R68 – SATELLITE CONTROL PARAMETER CHANGED

R70 – ZONE RESTRICTION MODIFIED

R72 – NUMBER PLAN TRANSLATION TABLE MODIFIED

R73 – ALTERNATE AREA ROUTING ESTABLISHED

Figure 4-38. AUTOVON Control Information Only Report Processing

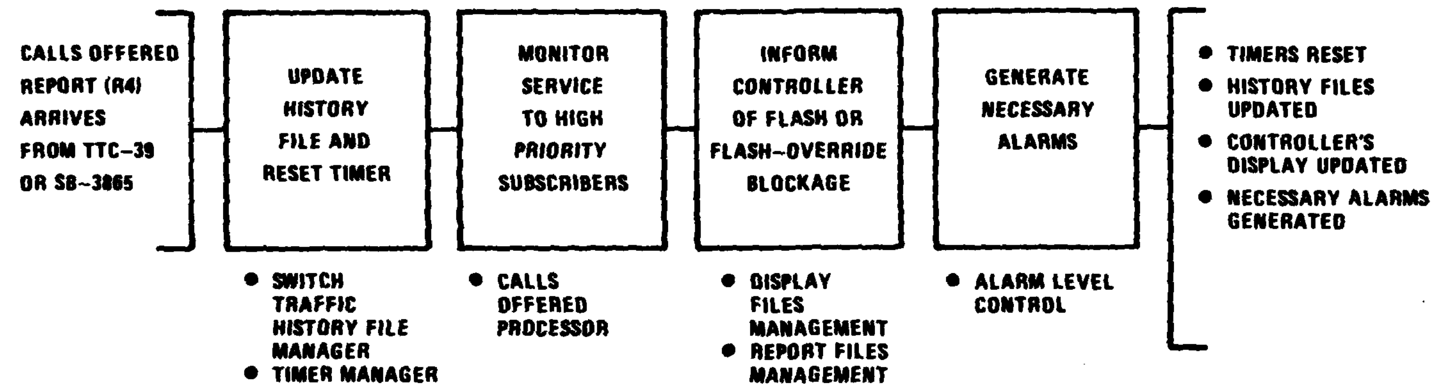


Figure 4-39. AUTOVON Control Calls Offered Report Processing

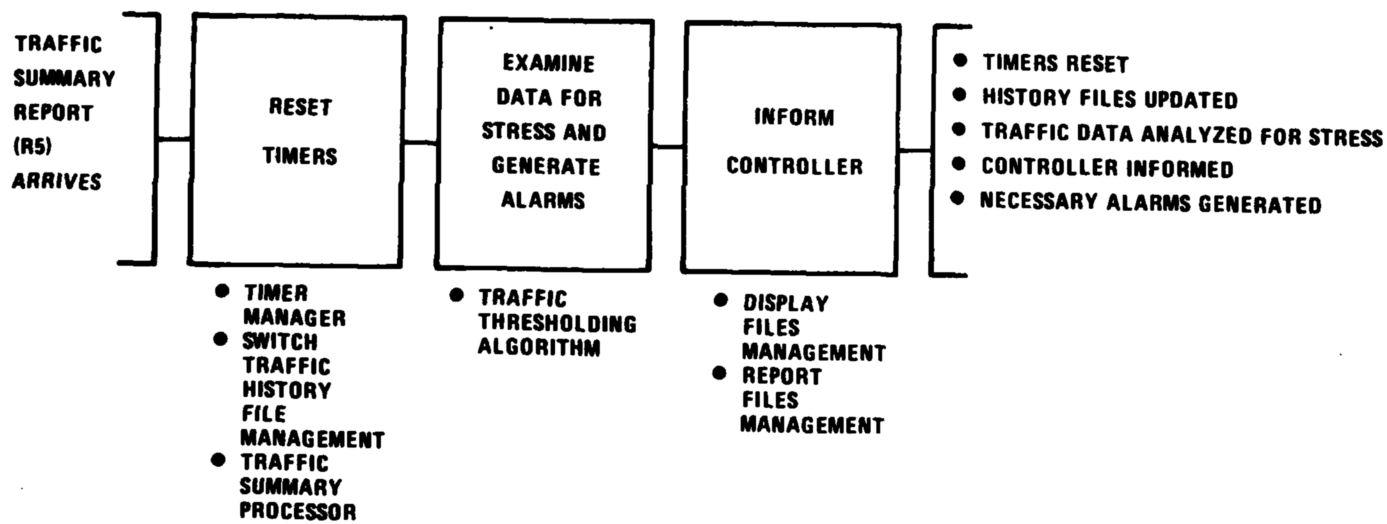


Figure 4-40. AUTOVON Control "Traffic Summary" Report Processing

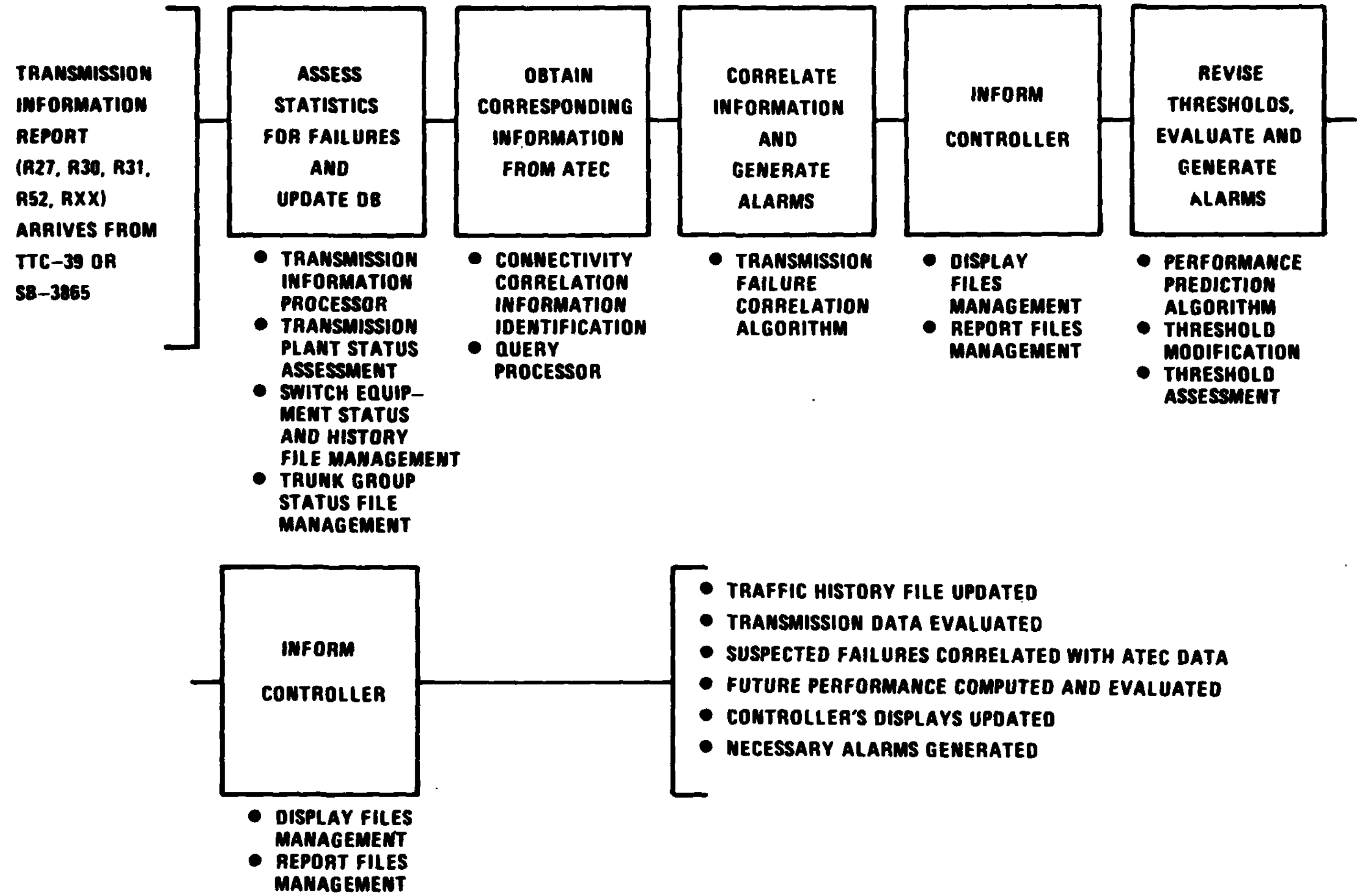


Figure 4-41. AUTOVON Control "Transmission Information" Report Processing

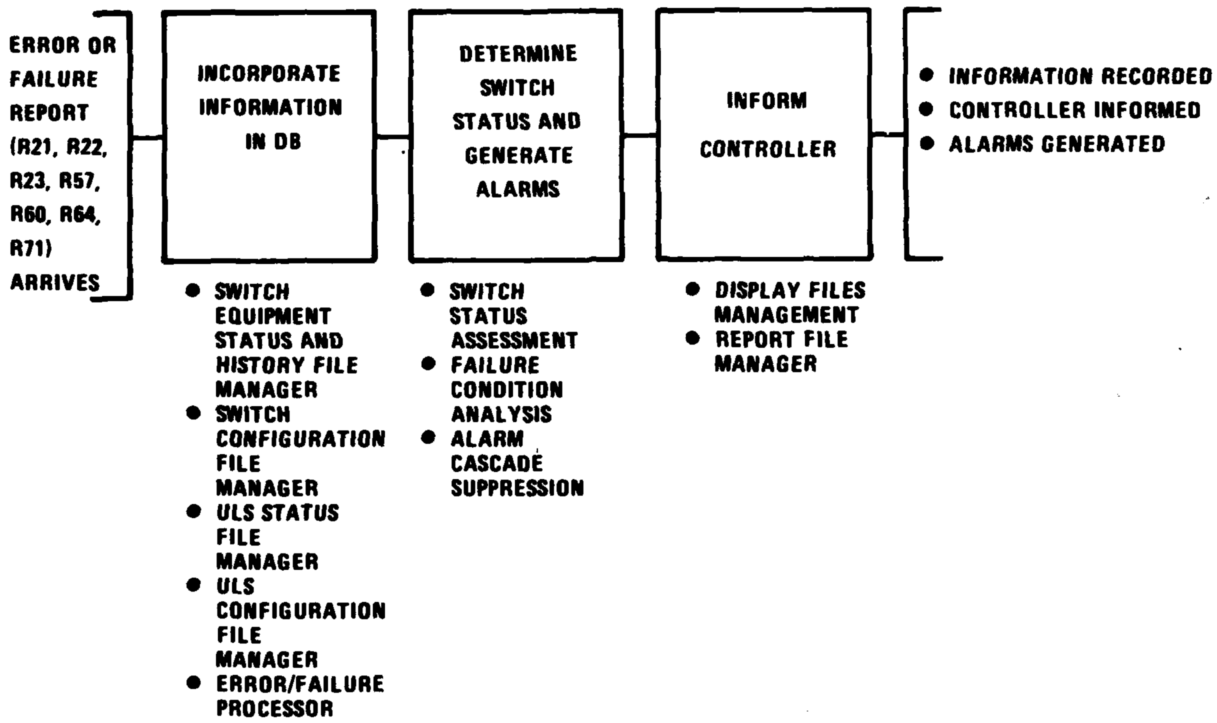


Figure 4-42. AUTOVON Control "Error" and "Failure" Report Processing

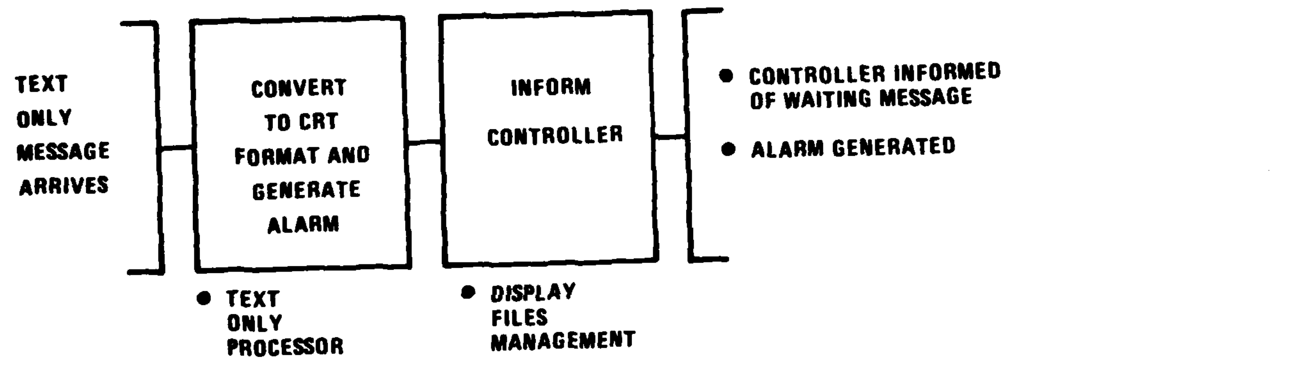


Figure 4-43. AUTOVON Control Text Only Message Processing

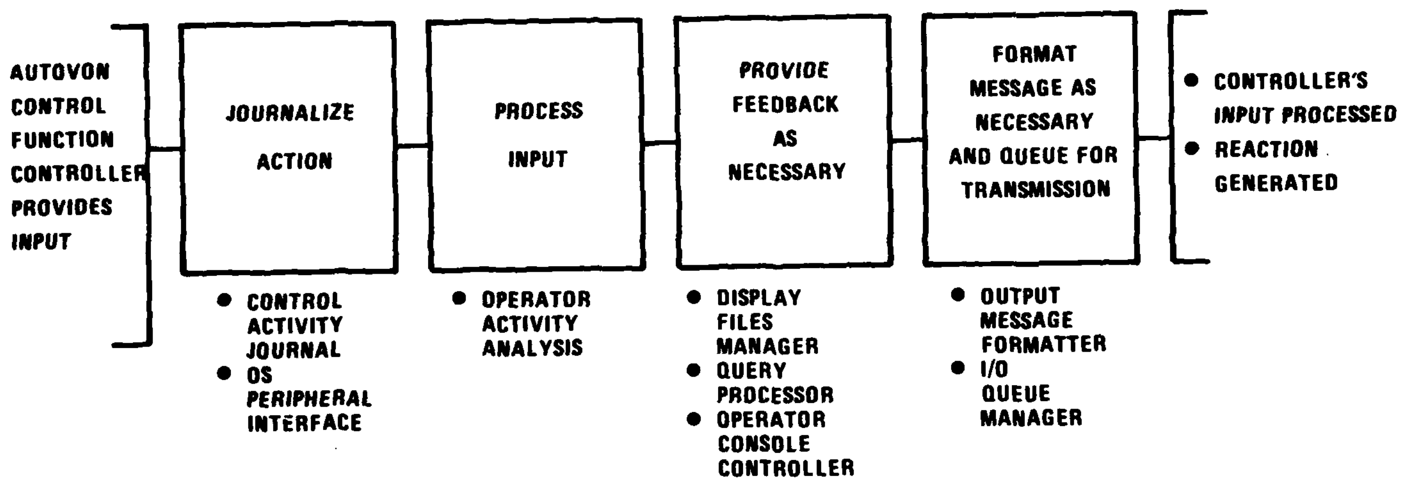


Figure 4-44. AUTOVON Control Operator Action

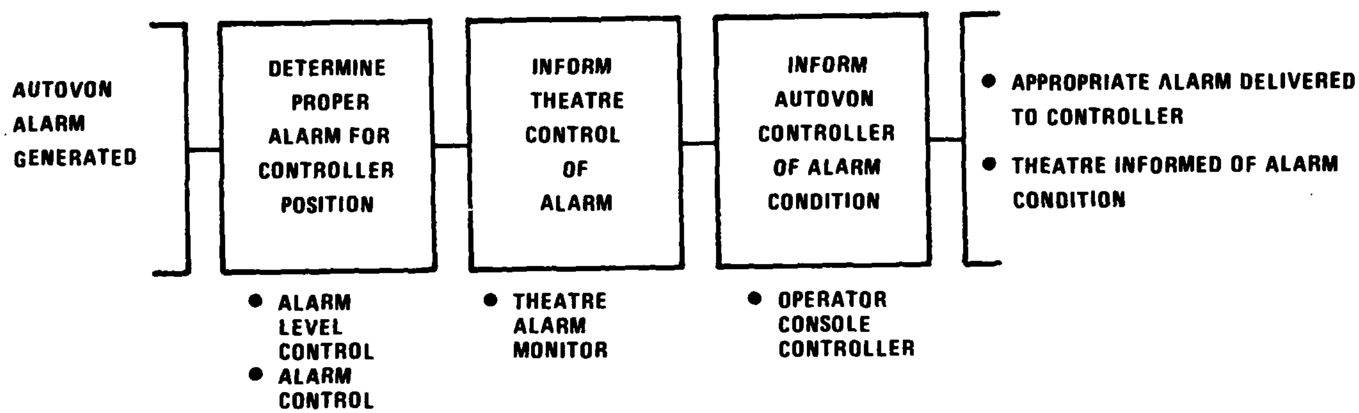
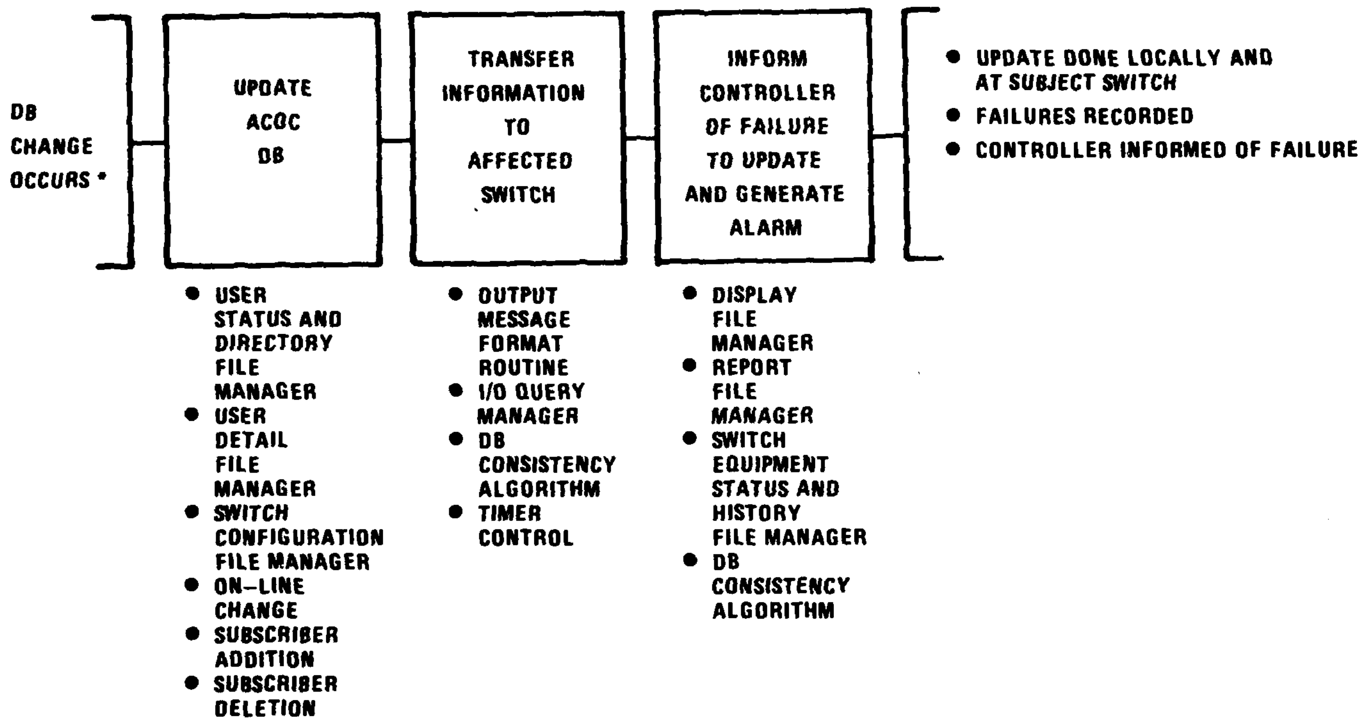


Figure 4-45. AUTOVON Control
AUTOVON Alarm Generation



* IN ADDITION TO ACOC, REPORTS (R2, R3, R6, R44, R47, R58, R65, R67, R69) FROM THE TTC-39 AND SB-3865 SWITCHES CAN INITIATE DB CHANGES.

Figure 4-46. AUTOVON Control DB Change

4.2 SOFTWARE MODIFICATIONS, ADDITIONS AND SIZING

A preliminary software design has been performed using the functional flow analysis described in Section 4.1. The new or modified software functions, routines and modules are identified for each subsystem and control level. A sizing analysis is provided for each routine or module identified together with a description of the software functions accomplished.

4.2.1 General

The system and subsystem modifications and additions are summarized in Table 4-3. All the software identified with the exception of the ACOC/WWOLS software and the software for the Report Consolidation Processor are modifications to existing systems. The two exceptions will require new processors and are new systems. The detailed results of the software sizing are given in Appendix B.

Program sizing is based on estimating the number of lines of HOL code required to implement the various program modules and routines. In determining the size of various routines, checks and comparisons with previous program sizing efforts were made where routines and functions were similar. Data was available from similar Honeywell programs, and from CSC and Western Union for similar systems and functions. See references 7 and 28.
The program occupancy for each HOL instruction used is 15 bytes. The assumption is that each HOL instruction expands into five assembly level instructions. This expansion is commonly experienced in available mini-computers. Further, each assembly level instruction requires, on the average,

TABLE 4-3. SUMMARY OF SOFTWARE MODIFICATIONS

SYSTEM/SUBSYSTEMS	SOFTWARE MODIFICATIONS
AUTODIN II - SNCC	Provide capability to transmit all PSN reports received to NCC-CONUS.
AN/TTC-39	Provide single trunk failure message and provide indication of Ring around Rosey condition.
SB-3865	Obtain and build messages for traffic parameters, obtain and build messages for status parameters, obtain and build message based on hardware diagnostic, provide and handle ATEC-10000 protocals and formats.
Report Consolidation Proc.	Interfaces nine SCAU's, consolidates reports to single channel to ACOC. Receives directives from ACOC routes to proper TTC-39/SCAU.
DSCS-TCE	Compute historical profiles for EIRP and RSS parameter, file for local display, provide alarm thresholds for operator alerting, transmit periodically to NCE.
	Report earth terminal status alarms to ATEC-CIS using ATEC 10000 formats and protocal.
	Report alarm exception reports to NCE.
DSCS-NCE	Receive and file EIRP and RSS historical profiles for local display, transmit to ACOC.
	Receive exception report from TCE record in data base, update display and transmit to ACOC.
ATEC-CIS	Message routing tables modified to accomodate messages to and from TCE, to and from ACOC, and from SB-3865 switchboard.
ATEC-NCS	Message routing tables modified as in ATEC CIS. Process TCE alarm message for correlation with terrestrial alarms, store faults, transmit uncorreclated faults to Sector.

TABLE 4-3. SUMMARY OF SOFTWARE MODIFICATIONS (Cont'd)

SYSTEM/SUBSYSTEMS	SOFTWARE MODIFICATIONS
ATEC-SCS	Message routing tables modified as in ATEC-CIS, transmit and receive message from ACOC on AUTODIN.
	Process TCE alarm messages from Node store and attempt correlation with terrestrial alarms.
ACOC/WWOLS	New software system to perform Syocon functions at the Theater level.

three bytes of storage. The result is 15 bytes for each HOL instruction and this value was used to compute program occupancy requirements.

Software routines that have been estimated in numbers of assembly level instructions use an expansion factor of 3 bytes per instruction to estimate program occupancy requirements.

4.2.2 Subsystem Software

The results of the software sizing for each subsystem are described below and summarized in Table 4-4. The subsystems included are:

- AUTODIN II
- SB-3865
- TTC-39
- The Report Consolidation Processor
- DSCS TCE
- DSCS NCE
- ATEC CIS
- ATEC Node
- ATEC Sector
- ACOC/WWOLS

AUTODIN II - SNCC--The AUTODIN II system control will be supported in the European Theatre by a copy of the NCC designated as the Sub-Network Control Center. The modification to the software consists of readdressing all messages sent to ACOC to the NCC-CONUS. Table B-1 summarizes the software sizing for the SNCC modifications.

TABLE 4-4. SYSTEM/SUBSYSTEM SOFTWARE SIZING SUMMARY

SYSTEM/SUBSYSTEM	# OF INSTRUCTIONS	STORAGE (BYTES) PROG.	DATA
AUTODIN II SNCC	25H	375	-
SB-3865	365H 230A	6,165	243
TTC-39	105H	1,575	24
Report Consolidation Processor	1,190A	3,570	890
DSCS TCE	235H	3,525	100
DSCS NCE	210H	3,150	200
ATEC CIS	30H	450	-
ATEC NCS	275H	4,125	-
ATEC SCS	235H	3,525	-
ACOC/WWOLS	18,575H	*	*

*See Section 4.2.3

H = HOL

A = Assembly Level

SB-3865 Modifications--The SB-3865 is modified to support a new I/O port through which is reported traffic and status parameters. Traffic parameters are sent periodically using ICD-004 R3, R4, R6 and R44 message contents. Switch status parameters are transmitted using R21, R22 and R23 message contents on status change occurrence. Hardware diagnostic failures are reported in a new message format. Output will be in ATEC 10000 format and protocol. No directives will be received. Table B-2 summarizes the SB-3865 modifications.

TTC-39 Modifications--The TTC-39 software is modified to provide a new message to indicate and identify a single trunk failure and to use the "A" field of an R60 message when the reason for sending this message is the detection of a "ring around rosey" condition. Table B-3 summarizes the modifications.

Report Consolidation Processor Software--The Report Consolidation Processor Software provides a data concentrator function and is executed by a microprocessor. The inputs from nine TTC-39 SYSCON channel acquisition units are processed, consolidated to a single channel and output. Inputs from the single channel (directives) are processed to determine address and routed to the correct TTC-39. Input processing includes message input, protocol handling, and error checks. Message processing includes format conversion, address detection, and I/O device control. Output processing includes message output, protocol handling and parity and LRC generation. Table B-4 summarizes the software additions for this processor.

DSCS-TCE--The software in the TCP is modified to provide additional alarming and upwards reporting for two parameters. Historical profiles will be computed for RSS and EIRP and will be reported periodically to NCE. In addition, TCE alarms will be fault isolated, converted to circuit or trunk impacted and reported to NCE on occurrence. Alarms affecting the terrestrial transmission system will also be reported to ATEC-CIS over the 150 baud data communication channel. ATEC 10000 formats and protocol will be used on this interface. Table B-5 summarizes these modifications.

DSCS-NCE--The software modifications at the NCE are associated with storing and displaying historical profiles on EIRP and RSS, reporting this data to ACOC, receiving alarm exception reports and reporting them to the ACOC. Table B-6 summarizes these modifications.

ATEC-CIS--The Communications Interface Subsystem (CIS) software modifications are required in the form of message routing table changes to accommodate messages to and from the new subsystems using it as a message handler/switch. These include messages to and from ACOC, the DSCS TCE, and the SB-3865. See Table B-7 for modifications.

ATEC-NODE--The software modifications in the Node processor include message routing table modifications similar to those in the CIS to accommodate new message sources and destinations, the processing of TCE alarm reports for correlation with TTS alarms and faults, storage of alarm data for future alarm correlation, and transmission of TCE alarm data to the

Sector Level in the event that correlation is not achievable. Modifications are summarized in Table B-8.

ATEC-Sector--The software modifications in the Sector processor include message routing table changes to accommodate new message addresses and processing and storage of TCE alarm reports forwarded from the Node for correlation with terrestrial transmission system status. See Table B-9 for software summary.

4.2.3 ACOC/WWOLS Software

The description and design of the software functions performed at the ACOC level are depicted in the functional flows presented in Section 4.1 These functions are broken into three areas of control: Theatre Control, Connectivity Control and AUTOVON Control as shown in the hierarchy charts, Figures 4-15, 4-16, and 4-17.

Each software module identified has been sized in terms of estimated lines of HOL code required to implement the routine plus additional memory required for data storage associated with the routine. The sizing estimates are primarily for application software and assume that the host computer has and supplies the operating system, diagnostics, data base management system.

The program sizing for ACOC/WWOLS is summarized in Table B-10. Program occupancy, as previously mentioned, is based on a ratio of 15 bytes of storage for each HOL instruction. The total number of HOL lines of code is

18,575; the total program occupancy, without overlays is 276,750 bytes, and the total data occupancy is 7,500 bytes.

Since the software is functionally broken into three areas of control, it is possible to incorporate an overlay structure to minimize processor memory requirements and take advantage of on-line secondary storage capabilities. The software modules were divided into resident routines and functional support routines. The resident routines are high usage, high demand routines such as CRT interface, I/O drivers, and message processors. The resident and support overlay sizing summary is shown in Table B-11. The resident routines require 18,750 bytes of memory while the support functions, broken into the three areas of control, are:

- o Theatre Control 27,225
- o Connectivity Control 27,750
- o AUTOVON Control 27,375

The routines required for each of the three major functions are shown in Tables B-12 through B-14. In each major functional area, only one sub-function need be in memory at a time. The ACOC processor memory requirements are determined by adding memory requirements for the resident routines, the support overlays and the largest functional overlay for each ACOC control function. The largest memory requirement is selected and added to the estimated operating system and system support software to determine total memory required. Table 4-5 summarizes this process. The largest memory requirement occurs for the Connectivity Controller and requires 95,625

TABLE 4-5. MEMORY REQUIREMENT FOR ACOC

Element	Resident	Support Overlay	Largest Functional Overlay	Total Occupancy (Bytes)
THEATRE	18,750	27,225	9,750	55,725
CONNECTIVITY	18,750	27,750	49,125	95,625
AUTOVON CONTROL	18,750	27,375	18,000	64,125

	Operating System	22,000
	System Pool	20,000
TOTAL	Data Base Management System	20,000
		62,000 Bytes

Total Memory Required - 157,625 Bytes

bytes of memory. The operating system, based on currently available real time operating system software, such as Honeywell GCOS 6-400, and a TOTAL data base management system require 62,000 bytes of memory. Thus the total ACOC memory requirement if 157,625 bytes based on this analysis.

Secondary storage requirements include the display data storage as well as the data base described in Section 3.4. These requirements are summarized in Table 4-6 . The total storage requirements for the Theatre data base is estimated to be 3,795,818 bytes.

4.3 HARDWARE MODIFICATIONS AND ADDITIONS

The hardware modifications and additions required to implement the parameter acquisition, status and performance data information flow and the associated software modifications are summarized in Table 4-7.

In general, the software modifications to the existing or planned subsystems do not require hardware augmentations to accompany them. In all cases, the minimum spare memory capacity specified in for the subsystems in question ranged from 20% to over 100% of the initial specified values. Of the subsystems requiring in excess of 1,000 bytes of memory to implement the software modification, the SB-3865 has the smallest memory (128K bytes). The sizing of the software modifications shows that the SB-3865 also has the largest modification in terms of program occupancy and data storage (6,400 bytes). Assuming a memory size of 128K bytes (it may be larger), 20% spare capacity translates to 25.6K bytes of usable memory. The SB-3865 modifications are assumed to be made in the spare memory provided. If 20% spare

TABLE 4-6. THEATRE DATA BASE SIZING (1 of 2)

	Record Size Bytes	Number of Records	File Size Bytes
Network Control			
Sector File	39	5	195
Node File	42	30	1,260
Station File	218	100	21,800
Connectivity Path File	276	25	6,900
Link File	161	410	66,010
Trunk File	509	1,250	636,250
Circuit File	214	10,500	2,247,000
Fault File	178	3,600	640,800
Network Conn. Display (19 Displays) Form	1,920	19	36,480
Input-Packed	600	19	10,400
Autovon Control			
Network Config File	2,342	1	2,342
SW Equip Status & Hist. File TTC-39	234	9	2,106

TABLE 4-6. THEATRE DATA BASE SIZING (2 of 2)

	Record Size Bytes	Number of Records	File Size Bytes
<u>Autovon Control</u> (Continued)			
SW Equip Status & Hist. File SB-3865	72	45	3,240
SW Config Table	130	9	1,170
SW Traffic File	30	54	1,620
Trunk Group Status File	903	25	22,575
Trunk Traffic File	78	25	1,950
Critical User Access Status F	30	100	3,000
VON Displays (26 Displays) Form	1,920	26	49,920
Input-Packed	600	26	15,600
<u>Theater Control</u>			
Theater Displays (6 Displays) Form	1,920	6	11,520
Input-Packed	600	6	3,600
<u>Autodin Control</u>			
Summary Display (4 Displays) Form	1,920	4	7,680
Input-Packed	600	4	2,400

TABLE 4-7 . SUMMARY OF HARDWARE MODIFICATIONS

SYSTEM/SUBSYSTEM	HARDWARE MODIFICATION	REMARKS
AUTODIN II SNCC	None.	Note 1.
SB-3865	Modified to provide new I/o port including communication line adaptor.	Note 1.
TTC-39	None.	Note 1.
SYSCON Channel Acquisition Unit	New special purpose hardware developed to extract and insert SYSCON from TTC-39 Digital Transmission Group.	
Report Consolidating Processor	New microprocessor based data link interface and concentrator to consolidate 9 TTC-39 SYSCON channels into a single data link to ACOC.	
DSCS TCE	None.	Note 1.
DSCS NCE	None.	Note 1.
ATEC CIS	None.	Communications Interface Subsystem assumed to have spare ports at sites requiring access. Note 1.
ATEC NCS	None.	Note 1.
ATEC SCS	None.	Note 1.
ACOC Level	New Processor and peripherals to support the ACOC Control functions.	

Note 1. Processor memory augmentation judged not to be required. See Section 4.3

memory is required to be maintained after the software modules are implemented, then an additional memory increment must be added to the system. We are assuming that unless more than half of the spare memory is utilized by a software modification, then no memory augmentation is required. All of the software modifications fall into the category where no hardware augmentations in terms of added memory increments are required to the existing systems.

4.3.1 Specific Hardware Modifications or Additions

SB-3865--The SB-3865 is modified specifically to provide an I/O port for reporting traffic and status parameters and hardware diagnostic failures. It is assumed that this I/O port is a newly developed, custom designed processor interface including data buffering, universal asynchronous receiver transmitter, control and timing and line drivers to provide the 150 baud asynchronous interface. Figure 4-47 shows a block diagram for this I/O port.

SYSCON Channel Acquisition Unit--The SYSCON Channel Acquisition Unit is a custom designed device for interfacing the digital transmission group external to the TTC-39 for the purpose of extracting and inserting data from one of the SYSCON subchannels riding the 16/32 Kbps overhead channel.

Figure 4-48 shows a block diagram of the SYSCON Channel Acquisition Unit. Data from the TTC-39 is clocked into the TX buffer by the TTC-39 clock. The 2901 bit slice microprocessor based Frame Sync circuit analyzes the data and determines where the frame sync bit is located, calculates the bit count delta from the sync bit to the required subchannel bit and initializes the

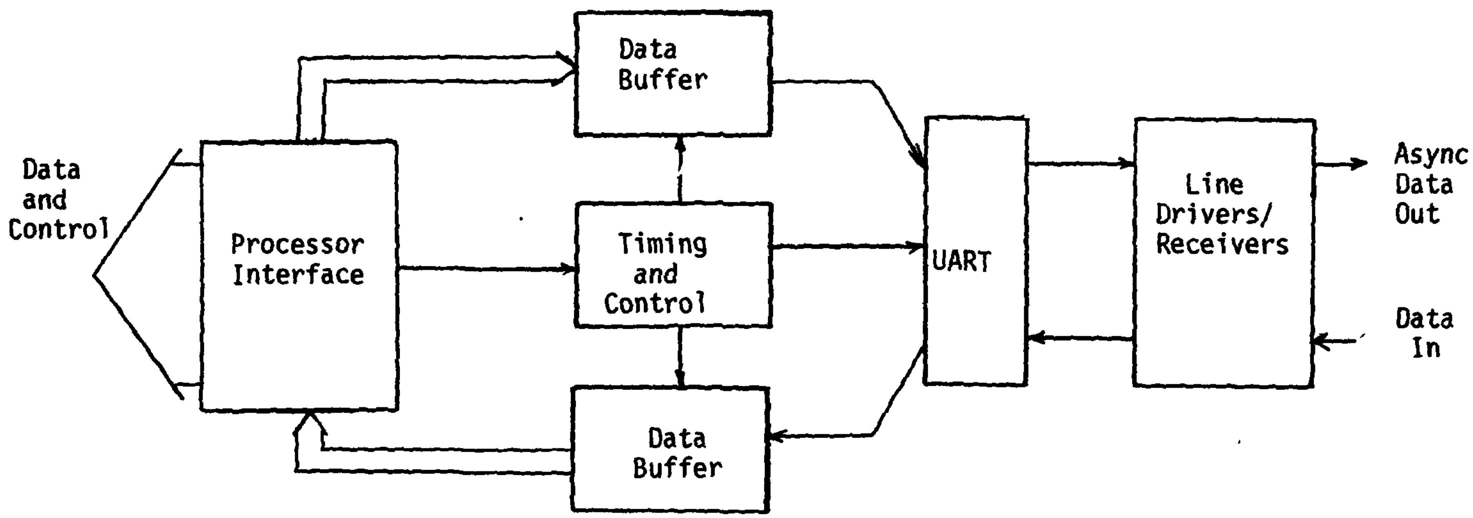


Figure 4-47. SB-3865 I/O Port Block Diagram

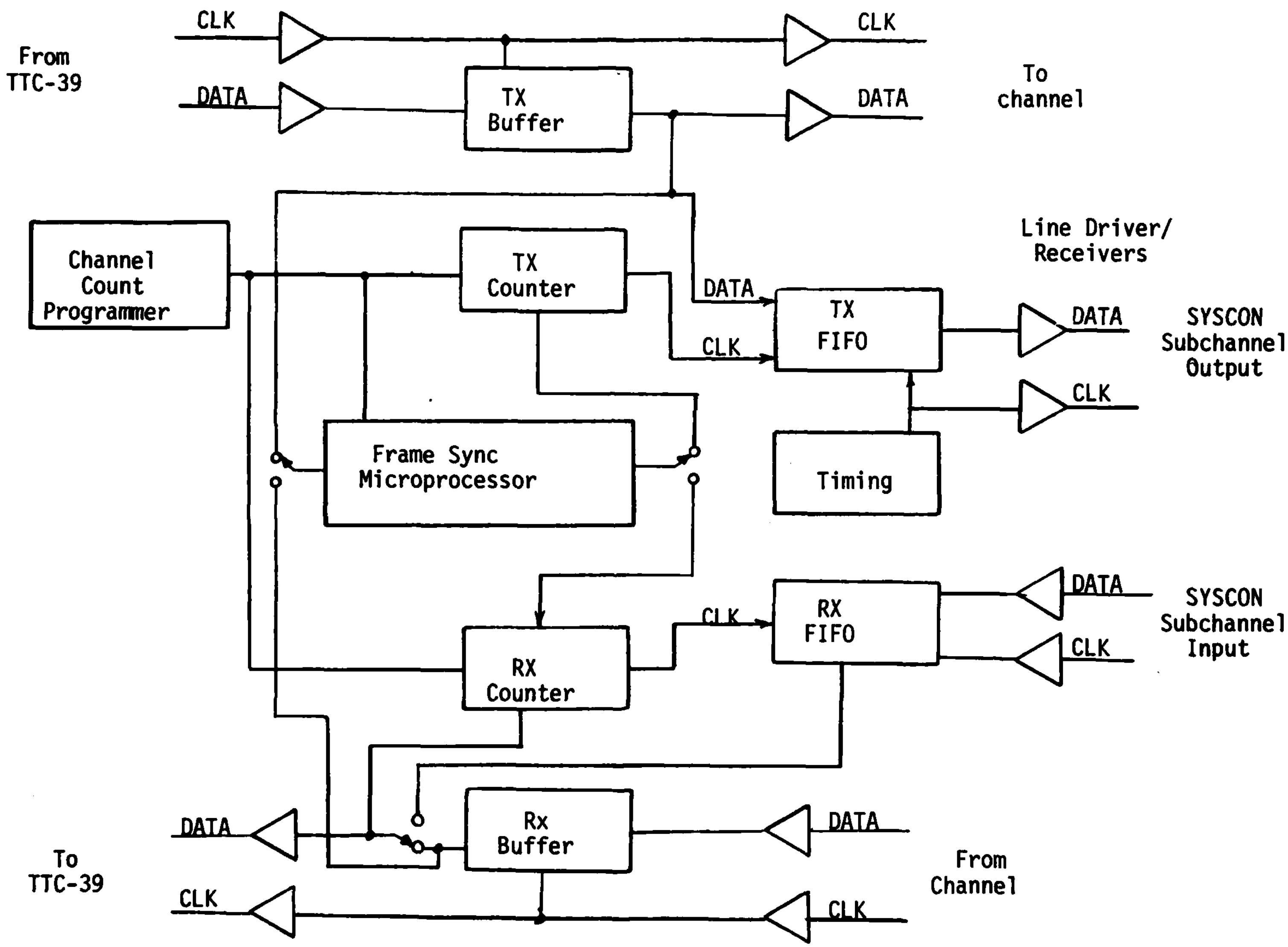


Figure 4-48. SYSCON Channel Acquisition Unit Block Diagram

TX counter when the next subchannel bit occurs. This causes the TX counter to output a clock pulse to the TX FIFO (First In, First Out Shift Register) which clocks the subchannel bit into the FIFO. The TX counter is a programmable counter whose maximum count is determined by the channel count programmer. This device is a set of dip switches which tell the counter and the microprocessor the number of bits between subchannel data bits. Thus, once the TX counter is initialized by the microprocessor, it counts data bits and each time it reaches its programmed maximum count it causes the next subchannel data bit to be clocked into the TX FIFO. The TX Counter operates independently of the Frame Sync Microprocessor except during initialization. The Frame Sync Microprocessor alternates between the TX subchannel circuit and the RX subchannel circuit guaranteeing a rapid resync should some system problem make this necessary.

The receive circuit works in a nearly identical fashion except that we wish to insert data rather than read it. Data comes in through the RX FIFO. When the RX counter reaches its maximum count, the multiplex switch at the output of the RX Buffer is switched away from the group data stream and the FIFO data bit is substituted for the one in the input group data stream. As in the TX subchannel circuit, the Frame Sync Microprocessor initialized the RX counter and the Channel Count Programmer set the maximum count.

Report Consolidation Processor (RCP)--The Report Consolidation Processor is a new system procured from standard, available components for the purpose of interfacing nine communication circuits from the SYSCON channel acquisition units and converting them to a single 2400 bps

synchronous circuit for routing to ACOC. The block diagram and recommended configuration for this system is shown in Figure 4-49. The system consists of the following components:

1 CPU with 16KW memory cabinet and power supply

1 Dual diskette and adapters

1 Console teleprinter and adapter

5 Communication adapters, 2 sync lines each

This system configuration is typical of those available from Digital Equipment Corporation or Honeywell Information Systems to perform this task. Support software and operating system software are available to support the special purpose application software identified in Section 4.2.2.

ACOC Hardware Recommendations--The ACOC hardware components recommended are shown in Figure 4-50. This hardware configuration is not unlike the configuration required for the ATEC Sector processor since the functions are similar. The primary functions are associated with data base and display management. The processor should be a state-of-the-art 16-bit minicomputer whose average instruction time is in the 2-8 microsecond range. Memory cycle time should not exceed one microsecond and the system hardware functions should include operators control panel, watch dog timer, real time clock, power fail/recovery and bootstrap loading capability. A full set of off the shelf hardware interfaces should be available for the peripheral and communication interfaces as well as proven support software. This software should include a real time disk operating system, peripheral drivers, data base

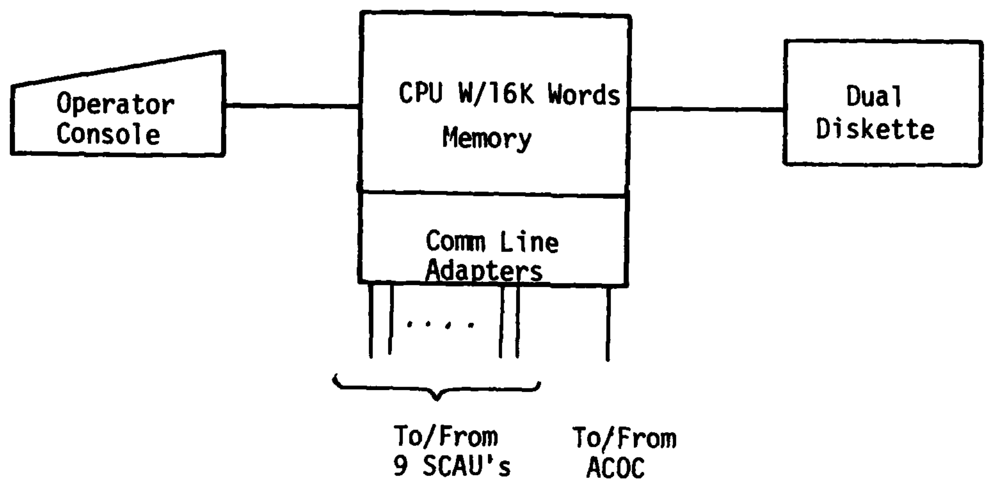


Figure 4-49. Report Consolidation Processor Configuration

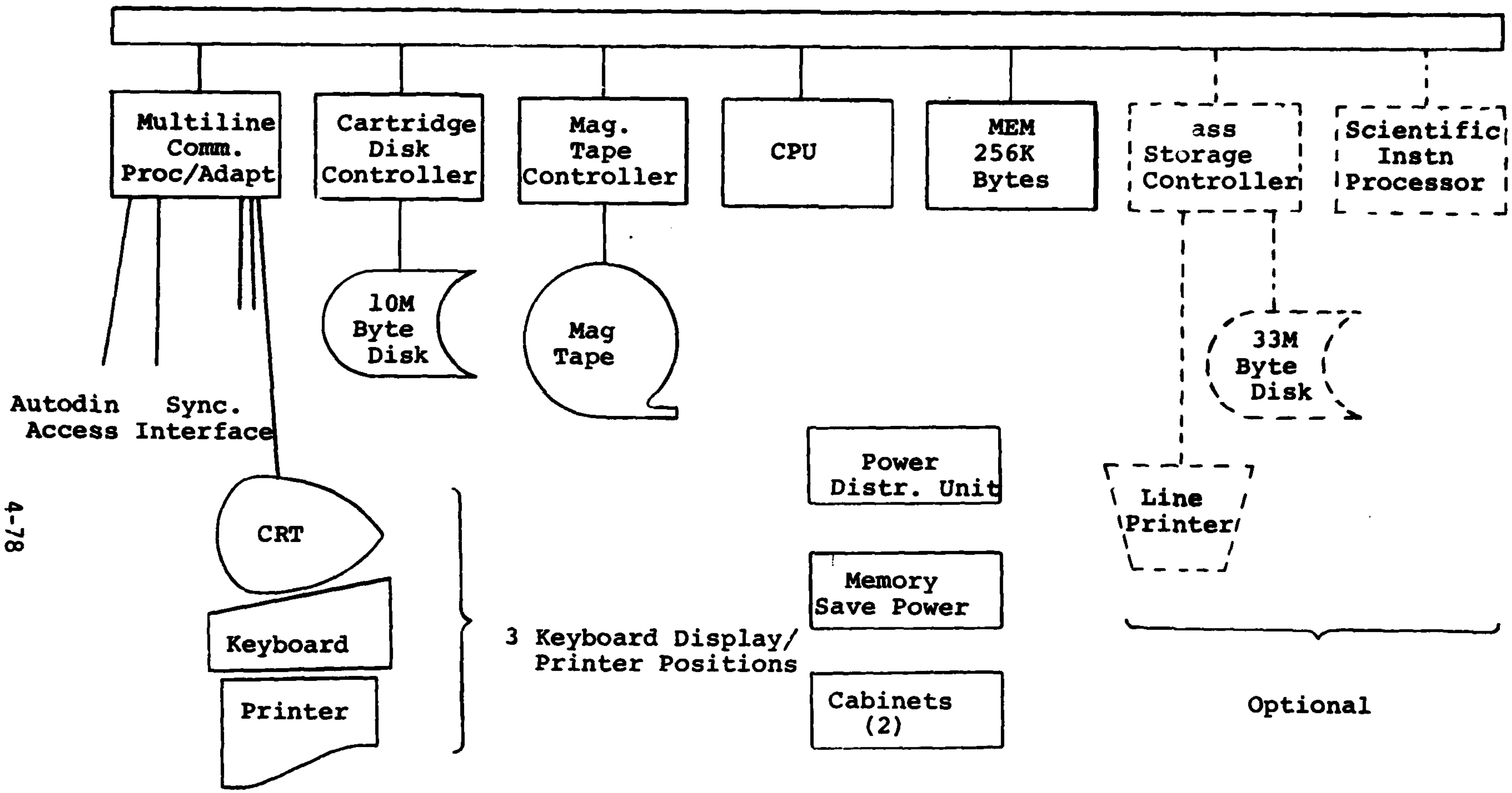


Figure 4-50. ACOC Computer System

management system, and HOL compiler.

Memory size initially is indicated at 256K bytes providing 63% spare memory for growth.

Peripherals and interfaces required include 10M bytes of disk storage for data base and program storage, a magnetic tape unit for journaling system events, three keyboard display/printer terminals to support the Theatre, AUTOVON and Connectivity Control functions. The CRT terminal equipment should be similar to the CRT terminal specified in ATEC 10000 Appendix 90. Features should include an intelligent terminal with 24 lines x 80 characters, control line, multipage storage, full CRT cursor and video display controls, function keys, protected fields, field tabulation and full ASCII set of alphanumerics and control characters.

4.4 HARDWARE AND SOFTWARE COSTS

Budgetary pricing for the hardware and software modifications/additions are included in this section. A summary of costs are shown in Table 4-8.

4.4.1 Hardware Cost Basis

For newly developed hardware, costs are presented for both the non-recurring development and the recurring production. The non-recurring costs consist of all costs necessary to obtain a productized unit/system and include:

- o Engineering Design and Technician Labor
- o Documentation Labor - Specifications, Part I and II Drafting, O&M Manuals

TABLE 4-8. BUDGETARY COST SUMMARY

SYSTEM/SUBSYSTEM	NON-RECURRING NEW HARDWARE DEVELOPMENT Labor (Man-days)	NON-RECURRING NEW HARDWARE DEVELOPMENT Costs Material $	RECURRING (OFF THE SHELF) HARDWARE Costs $	SOFTWARE Cost Labor (Man-days)
AUTODIN II SNCC	-	-	-	5
SB-3865	118	700	56,500	80
TTC-39	-	-	-	18
SCAU	175	1,000	22,500	-
RCP	-	-	19,950	100
DSCS TCE	-	-	-	40
DSCS NCE	-	-	-	35
ATEC CIS	-	-	-	5
ATEC NCS	-	-	-	46
ATEC SCS	-	-	-	40
ACOC/WWOLS	-	-	91,465	3096

- o Material - breadboard
- o Test - Plans and test labor

Recurring costs consist of production costs or off-the-shelf equipment costs.

Non-Recurring costs are quoted in terms of man-days of labor and material dollars.

Recurring or off-the-shelf costs are quoted in material dollars.

SB-3865 I/O Port Hardware Costs--The budgetary non-recurring new hardware development costs for the SB-3865 Custom I/O Port are estimated as follows:

o Labor (man-days)	118 man-days
--Includes Engineering design, documentation, drafting, board test software, technician baseboard test.	
o Materials (breadboard and test adapters)	$ 700

The budgetary recurring production costs per unit is estimated to be:	$ 1,130
o Includes material, assembly, labor and unit test. Assuming 50 SB-3865's deployed - total cost:	$56,500

SYSCON Channel Acquisition Unit Costs--The non-recurring costs are estimated as follows:

- o Labor (man-days) 175 man-days

  --Includes Engineering design, documentation, technician, board test software, drafting, breadboard test.

- o Materials (breadboard and test adapter) $ 1,000

The recurring production costs/unit: $ 2,500

- o Includes material, assembly labor and test unit. Total costs for nine units: $22,500

Report Consolidation Processor Costs--Table 4-9 shows hardware components that make up the RCP. These costs are representative of computer hardware available off-the-shelf which satisfy the requirements required for the Report Consolidation Processor.

ACOC Budgetary Hardware Costs--Table 4-10 summarizes the component costs for the ACOC processor system. These hardware costs are provided for currently available off-the-shelf equipment configured to satisfy the requirements identified earlier in the report.

4.4.2 Software Cost Basis

Budgetary software costs are quoted in man-days of labor. Software costs include design, code, debug and documentation. Documentation includes Software Specifications Part I and II, test plans, and users' manuals. HOL software is estimated at 6 lines of code/day. Assembly level language is

TABLE 4-9. REPORT CONSOLIDATION PROCESSOR COMPONENTS

QTY		
1	CPU, with 16K W Memory, Cabinet, PS,	$ 5,550
1	Dual Diskette unit and adapter	4,000
1	Operator console and adapter	2,900
5	Communication adapters, 2 sync lines each	7,500
		$19,950

TABLE 4-10. ACOC HARDWARE COMPONENTS/PRICING

EQUIPMENT	COST
CPU	$10,000
Memory 256 K Bytes	30,350
10 M Byte Moving Head Disk and Controller	12,700
Magnetic Tape Drive and Controller	11,000
Multiline Communication Processor with Line Adapters for 3 CRT Terminals and 2 Sync Commlines	4,400
CRT/Keyboard/Hard Copy Printer 3 @ $6,485	19,455
Cabinets/Power Distribution/Memory Battery Backup	3,560
TOTAL	$91,465

Optional

Scientific Instruction Processor	5,050
Mass Storage Disk 33M and Controller	21,000
Line Printer and Adapter	10,440

estimated at 12 lines of code/day. See Table 4-8 for the budgetary cost in man-days for each system/subsystem.

4.5 SUMMARY

Section IV has described the software required to implement the recommended system in terms of:

- o Functional flows
- o Size
- o Adequacy of existing systems to host the new software
- o Budgetary costs to develop the new software

The new hardware required has also been described and budgetary costs to develop and procure it have been estimated.

The changes required to the planned subsystems are minor, except in the case of the SB-3865. This is a result of the comprehensive reporting capabilities planned for the subsystems.

Capabilities of certain subsystems have been used to simplify data acquisition. Specifically, the routing of TTC-39 SYSCON channels to a central location uses the overhead channel of a Digital Transmission Group, and SB-3865 reports are routed through ATEC.

The addition of functions at ACOC is the most extensive modification to the systems as they are now defined. However, even this is anticipated, at least in part, by reference 31.

The next section of the report presents the parameter analysis and selection, which defines the data flows used by the system described in Sections II, III, and IV.

SECTION V

PARAMETER ANALYSIS AND SELECTION

5.0 INTRODUCTION

Parameters available from the subsystems of the DCS were reviewed in order to determine: a) which ones were useful for real time control and b) which ones were useful to long term engineering functions. Parameters selected for real time control must satisfy three objectives. First, parameters are required which indicate that real time controls are necessary. That is, the parameters will permit stresses to be detected and isolated. The current practices in this area provide guidance in making selections in this area.

Second, parameters necessary to select the control appropriate to a stress situation must be available to the decision makers. These parameters must convey the status of the networks.

Third, the parameters necessary to provide management visibility of the networks must be provided. This requirement comes from DCA Circular 310-55-1 for non-formatted reports (NRs). To meet this requirement, two techniques are possible. Either the reporting structure currently in use to support 310-55-1 NRs can be retained, or these reports can be automated. The benefits of automating the 310-55-1 NRs will be considered on a subsystem by subsystem basis.

The criteria for selecting parameters necessary for long term engineering are based on current requirements. There are two areas of interest in long term engineering. First is performance assessment. Data of use in this category include fault histories and results of performance measurements. Current requirements in this area served as guidelines.

The second area in long term engineering is the need to maintain the circuit/trunk data base. DCA circular 310-65-1 documents the data required in that data base. The data which will be required for this prupose will be any permanent reassignment of channels to different users.

For both of these categories, data available from the subsystems which would fulfill these requirements were analyzed.

The parameters selected are reflected in the displays and data base described in Sections II and III. The following subsections discuss the parameter selection for these subsystems:

- AUTOVON, TTC-39 and SB-3865
- AUTODIN II
- ATEC
- The DSCS Control Segment

5.1 AUTOVON PARAMETER ANALYSIS

This section contains the traffic and equipment status parameter analysis and selection for the TTC-39 and SB-3865 switches. Reporting requirements for the TTC-39 are detailed in ICD-004. On the other hand, the specification

for the SB-3865 contains no requirements for reporting SYSCON information. The SB-3865 does, however, record and present a subset of the ICD-004 information to the local operator. It is, therefore, recommended (see Section III) that the information recorded by the SB-3865 be reported according to the ICD-004 requirements for the TTC-39.

5.1.1 Traffic Parameter Selection

The selection of traffic parameters is based on that for which system control uses traffic parameters. There are two types of information which might be obtained from traffic parameters as follows:

- o Status of equipment used by or belonging to the network
- o Level of demand for network service, i.e., traffic level

The use of traffic parameters for the assessment of equipment status is not recommended for the following reasons:

- o All forms of equipment status changes can either be alarmed on occurrence, or can be monitored by scanning at frequent intervals.
- o Traffic parameters, being driven by a stochastic process, require extensive smoothing before being applied to an alarm threshold.
- o Network equipment status changes have complex, nonlinear interactions with traffic parameters throughout the network.
- o It would be very difficult to separate traffic parameter changes due to network status changes from those due to traffic level changes.

Therefore, traffic parameters should be used only for determining the network traffic level. Also, since the history of the actual traffic level is completely independent of the future traffic level, there is no way that traffic parameters could be used to predict or trend traffic levels. Traffic level predictions can only be made based on daily, weekly and seasonal business cycles and other external information such as DEFCON.

The traffic parameter selection matrix for the AUTOVON/AUTOSEVOCOM TTC-39 switch is shown in Table 5-1 that for the SB-3865 is shown in Table 5-2. They are based on the analysis contained in this and the following paragraphs.

Parameter Discussion--There are three types of traffic parameters, as follows:

- o Node parameters
- o Trunk group parameters
- o Source-destination pair parameters

Node parameters give information about the traffic at the switch making the report. The node parameters defined in ICD-004 for the AN/TTC-39 and SB-3865 are the following:

- o Local calls offered
- o Call originations offered
- o Call terminated
- o Tandem calls

TABLE 5-1. AUTOVON TTC-39 TRAFFIC PARAMETER SELECTION MATRIX

Node Parameters	Sampling Interval (Min)	Real Time Use	Long Term Engineering Use	Level of Visibility Processing	Communication Flow: Node Sector	Communication Flow: Sector Area	Stress Sensitve To	Trendable
Local Calls Offered	60		X	Area	.015	.015	N/A	No
Call Originations	60		X	Area	.015	.015	N/A	No
Calls Terminated	60		X	Area	.015	.015	N/A	No
Tandem Calls	60		X	Area	.015	.015	N/A	No
Calls Blocked, by Precedence	10		X	Area	.18	.18	N/A	No
Calls with dial tone delay>1sec	10		X	Area	.18	.18	N/A	No
Calls complete, by node	60		X	Area	.3	.3	N/A	No
Trunk Parameters *								
Calls offered, total	10	X	X	Area	.65	.65	Traffic Overload	No
Calls offered, by precedence	10		X	Area	1.62	1.62	N/A	No
Calls blocked - no idle trunk	10	X	X	Area	.65	.65	Traffic Overload	No
Calls blocked - no common equipment	10		X	Area	.65	.65	N/A	No
Calls incoming	10			Area	.65	.65	N/A	No
Calls preempted, by precedence	10		X	Area	1.80	1.80	N/A	No
Preempts blocked, by precedence	10		X	Area	1.62	1.62	N/A	No
Average number of trunks busy	10		X	Area	.65	.65	N/A	No
				Total	8.83	8.83 bits/sec		

*These parameters are reported on each trunk group.

TABLE 5-2. SB-3865 TRAFFIC PARAMETER SELECTION MATRIX

NODE PARAMETERS	TTC-42 REPORT NUMBER	SAMPLING INTERVAL (MIN)	NEAR REAL TIME USE	LONG TERM ENGINEERING USE	LEVEL OF VISIBILITY PROCESSING	COMMUNICATION FLOW (BPS) NODE SECTOR	COMMUNICATION FLOW (BPS) SECTOR AREA	STRESS SENSITIVE TO	TRENDABLE
LOCAL CALLS OFFERED	R44	60		X	AREA	.015	.015	N/A	NO
CALL ORIGINATIONS	R44	60		X	AREA	.015	.015	N/A	NO
CALLS TERMINATED	R44	60		X	AREA	.015	.015	N/A	NO
TANDEM CALLS	R44	60		X	AREA	.015	.015	N/A	NO
CALLS BLOCKED, BY PRECEDENCE	R3	10		X	AREA	.18	.18	N/A	NO
CALLS WITH DIAL TONE DELAY > 1 SEC (NEW PARAMETER)	R3	10		X	AREA	.18	.18	N/A	NO
TRUNK PARAMETERS									
THESE PARAMETERS ARE REPORTED ON EACH TRUNK GROUP									
CALLS PREEMPTED, BY PRECEDENCE	R6	10		X	AREA	1.80	1.80	N/A	NO
PREEMPTS BLOCKED, BY	R4	10		X	AREA	1.62	1.62	N/A	NO
					TOTAL:	3.84	3.84 BITS/SEC		

- o Calls blocked, reported by precedence
- o Calls with dial tone delay greater than 1 second

The first four parameters are part of statistical report R44, and are available in 15, 30, 60, 480, or 1440 minute reporting intervals. The last two are in real time report R3, available in 2.5, 5, or 10 minute intervals.

Node parameters do not provide enough detail for real time system level control since they either report on strictly local problems or are too summarized to provide a clear picture. Local calls offered does not provide any information about network operations, and if too many calls have delayed dial tone the local switch controller should apply traffic load control to reduce the demand. Both parameters relate to strictly local phenomena. The remaining parameters summarize the traffic at the switch, and could indicate an overall switch overload. They provide no detail about the characteristics of the overload, which is needed to isolate the stress. This detail is provided by the trunk group parameters.

The TTC-39 can measure and report trunk group parameters on up to 28 trunk groups at any given time. Since the maximum number of trunk groups connected to any switch in the AUTOVON System is 9, for all practical purposes the TTC-39 can report on all trunk groups simultaneously. The parameters collected for each trunk group include the following counts of events:

- o Calls offered, total and itemized by precedence
- o Calls blocked due to lack of idle trunks

- Calls blocked due to lack of common equipment
- Calls incoming on the trunk group
- Calls preempted, by precedence
- Preempts refused, by precedence

Calls offered (attempts) is the basic traffic parameter. It is a direct count of every attempt to use the trunk group. By assuming an average time which any call would use the trunk, calls blocked and preempted can be estimated via the Erlang formulas.

Calls blocked due to the lack of idle trunks (overflows) is the next most direct traffic parameter. Using this count along with the number of calls offered provides an estimate of trunk group performance which does not depend on assumptions about the hold times or the statistical distribution of attempts. There are disadvantages to using this parameter, as follows:

- Poisson statistics, using a historically derived hold time, predict network performance fairly well. This is especially true in a network like AUTOVON where trunk groups are not used as strictly high usage or final trunk groups but have some of each kind of traffic.

- Overflows are noisier than attempts, i.e., they come less frequently and tend to come in clumps, and thus a performance estimate based on overflows would need more smoothing than one based on attempts.

It would be useful to filter and threshold the ratio of overflows to attempts as a backup to thresholding just attempts in case the average hold time changes drastically due to military conditions for example. It must be recognized that the observed call blocking ratio will be slower to respond when appropriately filtered than the attempts parameter. Details of the relationship will be discussed in a later section.

Calls blocked due to lack of common equipment is a management oriented parameter. Common equipment is normally sized in a TTC-39 so that no calls are blocked, even in an overload situation. If calls are being blocked due to common equipment, the only control response is to reduce originating traffic, a local function. This is because common equipment is not used by tandem calls in a TTC-39 network. The only high level function associated with common equipment blocking is to allocate more units to the switch, which is not a real time control.

Calls incoming on the trunk group is a redundant parameter which is not useful if the control point has visibility of both ends of the trunk. It is just attempts minus overflows from the other end. This parameter would be useful if some sort of distributed control scheme was contemplated, but it has no place in the DCS hierarchical control structure.

Calls preempted and preempts refused are indicators of the basic traffic level, but they are very noisy parameters and hence not useful for real time system control. They are noisy in the sense that a preempt attempt is generated only if all alternate routes overflow on an idle search. Each

time an overflow process occurs, it has a larger ratio of variance to mean than the arrival process which generated it. Since a preempt is an overflow of the final trunk group, prempts have a very large variance to mean ratio. In addition to being noisy, preemption counts still contain only basic traffic intensity data the same as idle attempts. Therefore, these parameters are not useful for real time system control. They are useful for long term engineering studies to determine if the precedence system is operating properly. In some network designs, preemption algorithms transfer precedence ratings between calls in an erroneous manner. This could be detected by long term analysis of preemption count data.

The last trunk group traffic parameter collected by the TTC-39 is called number of trunks busy. It is obtained by scanning the trunk group every 30 seconds and counting the number of trunks either busy or reserved at each precedence level. Those trunks which terminate locally are excluded from the count. The 30 second scan results are then averaged over the measurement interval of 2.5, 5, or 10 minutes. This parameter is similar to trunk utilization, which is a traffic parameter that has been extensively analyzed. It is not trunk utilization however and should not be confused with trunk utilization. Trunk utilization includes terminating as well as tandem or originating calls, and is based strictly on usage, not a reservation. The trunks busy parameter in the TTC-39 has been so distorted that it doesn't really bear any specific relationship to the traffic on the

trunk group except that they tend to move in the same direction. It is therefore not useful for real time system control, nor for long term studies of traffic patterns.

There is only one node-node parameter in the TTC-39. It is calls completed, by node. If its companion parameter, calls attempted, or equivalently calls blocked were also available it might be of some use in real time control. The ESS4 switch uses a parameter like this for its traffic control algorithm. However, without some knowledge of calls attempted node to node this parameter is useful only as a historical record of node-node traffic carried in the network.

Smoothing of Traffic Parameters -- Traffic parameters are random variables and therefore typically have to be smoothed to be useful. The smoothing required is very much a function of the exact use of the parameter and some arbitrary decision criterion. In the case of system control, the expected use of the smoothed parameter is to make a decision whether the observed parameter came from a stressed traffic situation or from a normal unstressed traffic situation. This decision is made by placing a threshold on the smoothed parameter value. An arbitrary criterion for the goodness of the decision process can be made by the thresholding. Although this criterion is completely arbitrary, it is reasonable in the sense that if traffic alarms are continually being issued by the system control system, the network controllers will soon learn to ignore the alarms. An average of one alarm per shift would probably be tolerable.

With these conditions we can estimate the smoothing time required as a function of the definition of stress for any traffic measurement for which the mean and variance are known. An appropriate smoothing time can be obtained by approximating the measurement distribution with a Gaussian distribution which has the same variance in the stressed as in the unstressed condition. Then the minimum probability of error is

$$P_e = 2 \int_{\frac{\mu_1 + \mu_2}{2}}^{\infty} \frac{1}{2\pi\sigma} \, e^{\frac{(x - \mu_1)2}{2 \;\; 2}} \, dx = 2\mathrm{erfc} \, \frac{\mu_2 - \mu_1}{2\sigma}$$

where μ_1 is the mean of the unstressed distribution

μ_2 is the mean of the stressed distribution

σ is the standard deviation

In general, the standard deviation is proportional to the reciprocol of the square root of the smoothing time. Also, if a sample of data is collected, a single decision is on the data set, and none of the data is reused in the next decision, the average time between errors is approximately

$$T_e = t_{s/P_e} \stackrel{\Delta}{=} 8 \text{ hours}$$

Combining these equations and normalizing to the hold time yields

$$320 \, \mathrm{erfc} \, \frac{\Delta\sqrt{t_s}}{2\sigma_1} = t_s$$

where t_s is the smoothing time in hold times

Δ is the difference between the mean of the stressed and unstressed distributions

σ_1 is the variance of the measurment for a one hold time smoothing interval.

This equation for smoothing time can be solved given only the ratio of Δ/σ_1.

Smoothing of Observed Blocking--A common function used to determine traffic conditions is the ratio of calls blocked (O) to calls attempted (A). The variance of this function for a wide range of traffic conditions is shown in Figure 5-1. This figure is taken from reference (26), where the variance of the function was derived. Applying the equation for smoothing time derived in the previous section yields Figures 5-2 and 5-3. The general characteristics demonstrated by Figure 5-3 and the following:

- o Required smoothing decreases with larger trunk groups.
- o Required smoothing decreases with heavier traffic.
- o Required smoothing increases with the peakedness of the traffic.
- o Smoothing time is more sensitive to nominal GOS than it is to the number of trunks in the group or the peakedness of the traffic.

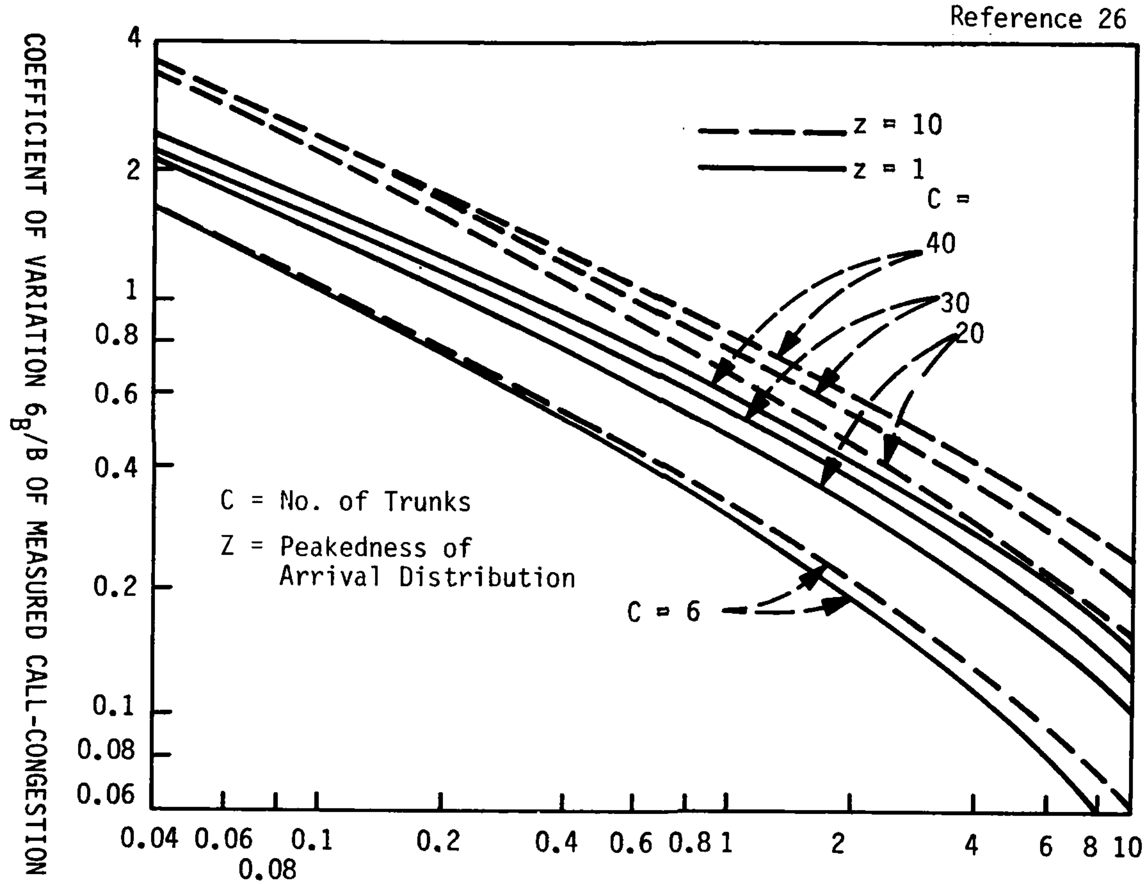


Figure 5-1. Normalized Variance of Overflow Counts

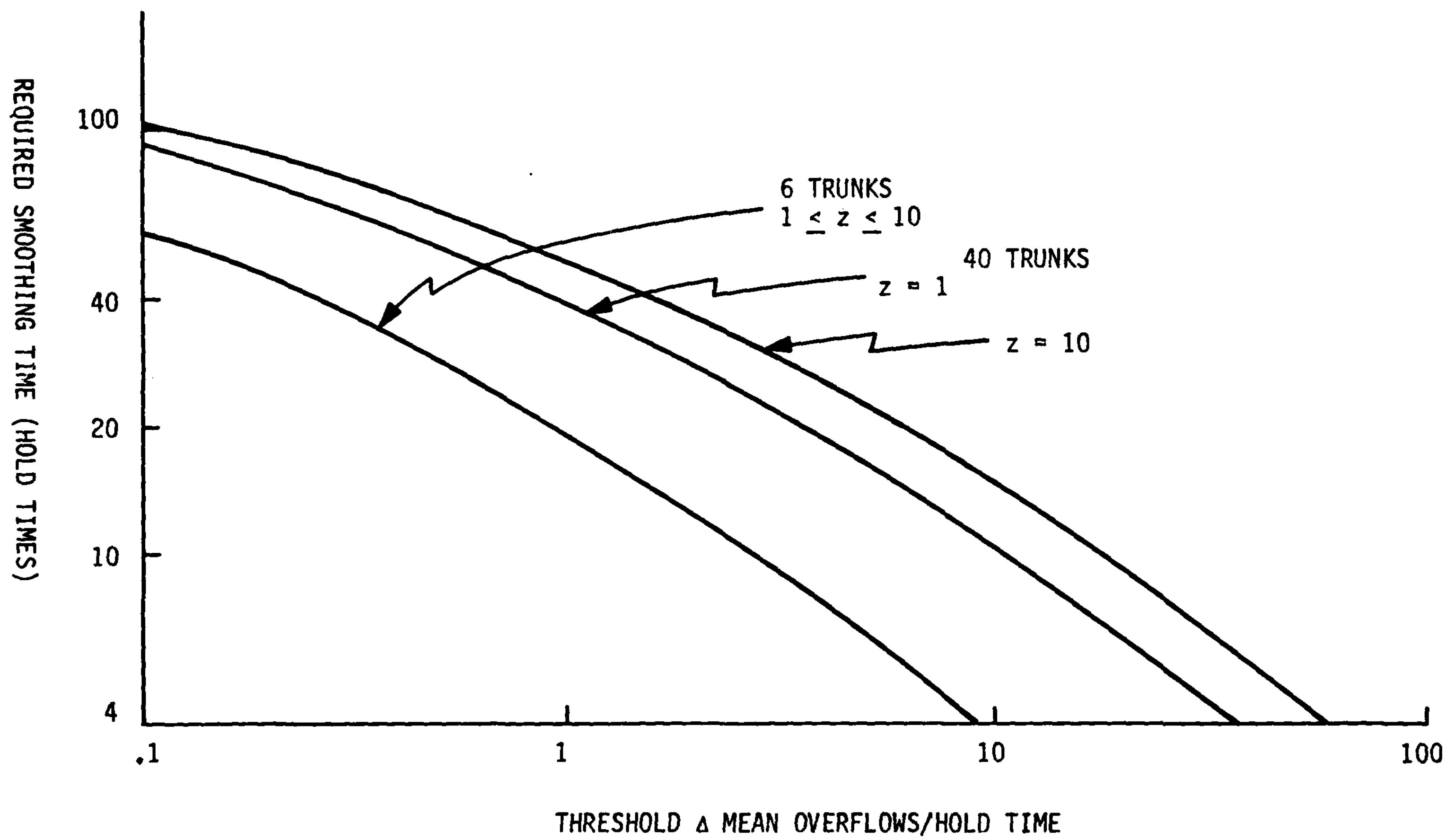


Figure 5-2. Overflow Smoothing Time as a Function of Overflows

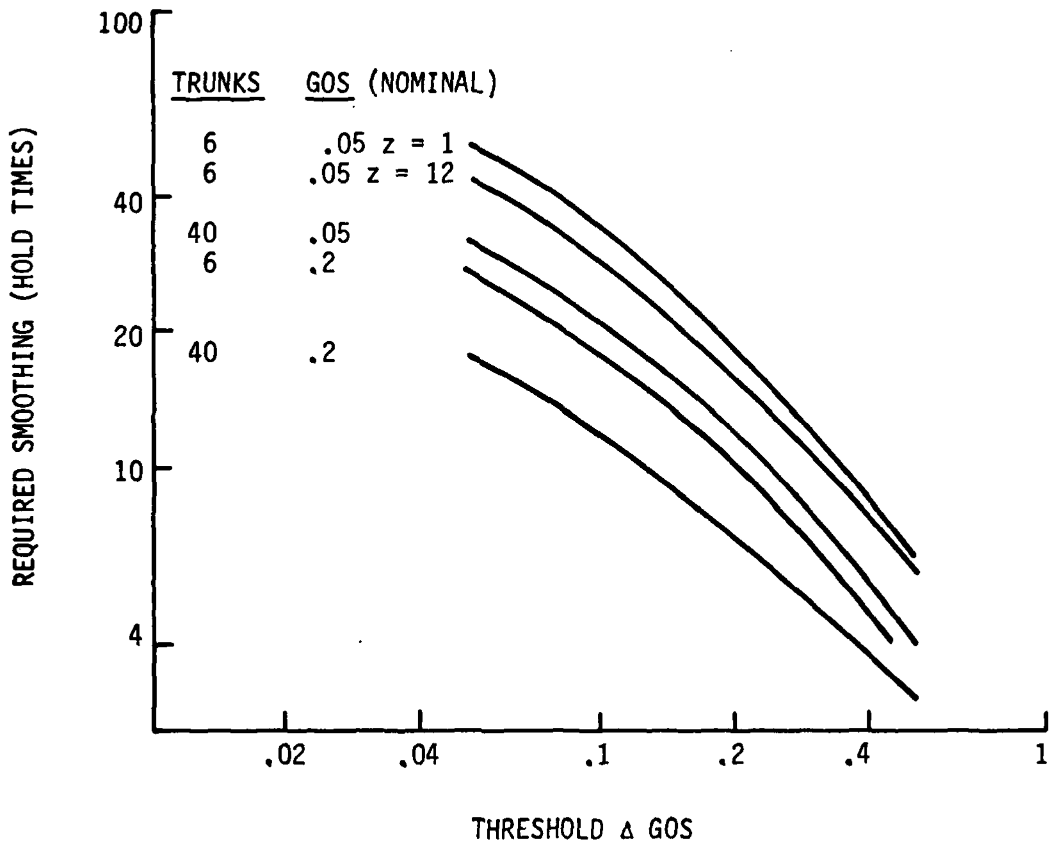


Figure 5-3. Overflow Smoothing Time as a Function of Threshold GOS.

The definition of stress is a matter of operational policy but, as an example, if it were desired to detect a change from .05 GOS to .15 GOS, the O/A ratio would have to be smoothed between 17 and 35 hold times depending on the size of the trunk group and the traffic peakedness. This corresponds to from 50 to 100 minutes of smoothing.

Thirty minute smoothing would allow detection of a change from .05 to .35 GOS on a 6 trunk group or from .05 to .25 GOS on a 40 trunk group. Since these are fairly substantial performance degradations, a 30 minute smoothing time would be a reasonable minimum for smoothing overflows.

Smoothing of Call Attempts--An alternative traffic parameter for determining traffic level is the number of call attempts, used by itself. In this case, the Erlang blocking formula gives an estimate or trunk group blocking. Since this is a monotonic relationship, a threshold applied directly to the number of attempts will yield the same results as a threshold applied to the trunk group performance estimate. The variance in measured call arrival rate, assuming a Poisson source, is

$$\left(\sigma/\lambda\right)^2 = \frac{\lambda}{t} + \frac{1}{t^2}$$

where λ is the estimated arrival rate. For large t, the t^2 becomes negligible. Since in this case the variance is proportional to the mean, some modification of the basic smoothing formula is required. A simple, first order approximation is to use the mean of the stressed and unstressed traffic's

standard deviation as the common standard deviation. This allows the continued use of a simple decision formula and provides a good approximation for error rate. Figure 5-4 shows the resulting smoothing time as a function of the detectable change in GOS. Compared to Figure 5-3 the smoothing times in Figure 5-4 are shorter for an equivalent threshold and nominal traffic situation. Smoothing times on the order of 30 minutes provides a ΔGOS sensitivity of about .2 on small groups down to .1 on larger groups. Since, for any smoothing time, a smaller change in grade of service can be detected using arrivals rather than the O/A, the arrival count by itself is a better parameter for traffic stress detection.

The computations were made based on a very simple filtering mechanism, and a simple decision rule. More sophisticated filtering algorithms and decision rules are available to reduce these times somewhat, but the basic conclusion that for reliable automatic thresholding of traffic parameters, long smoothing times are required is still valid. The general trend of these parameters is that for larger, more heavily loaded trunk groups the smoothing time is shorter whereas with smaller, more lightly loaded groups the smoothing time is longer. In any case, the functions is nowhere near as sensitive to trunk group or loading factors as it is to the threshold delta and time between errors assumptions. These assumptions must be established according to operational exigencies.

Relation of Traffic Parameter to Network Status Parameters--The use postulated for traffic parameters is to detect changes in network traffic loads.

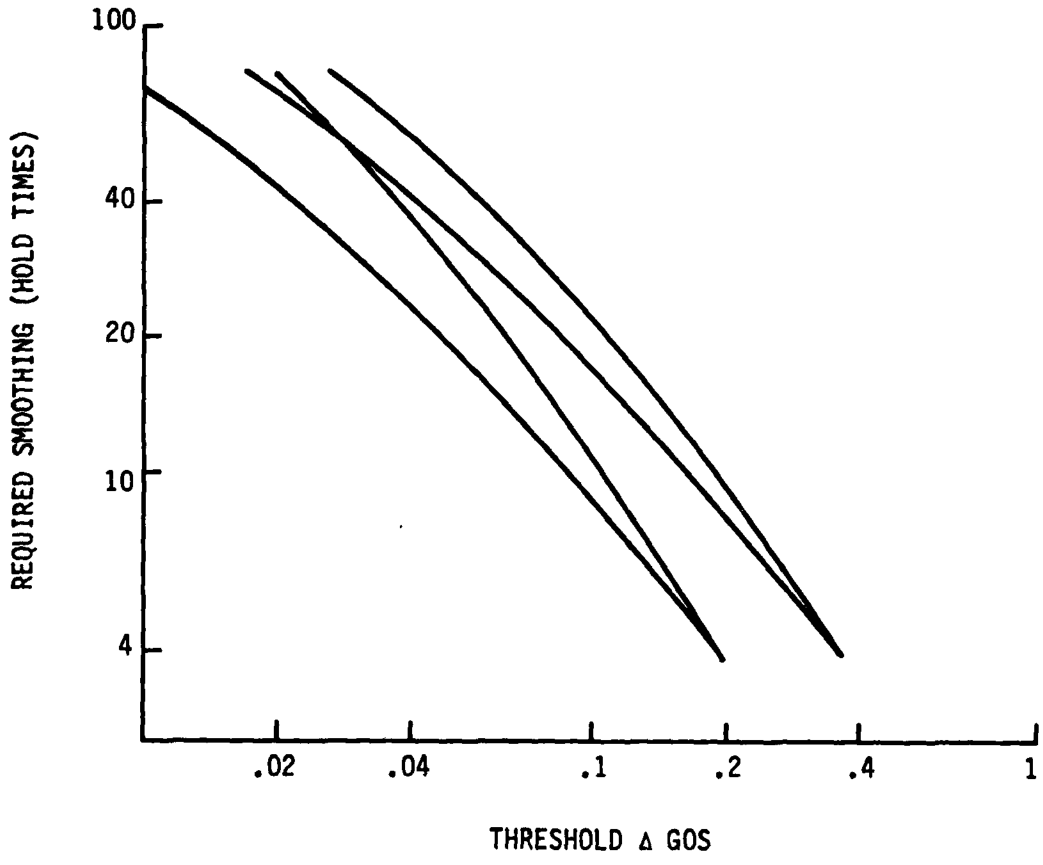


Figure 5-4. Arrival Smoothing as a Function of Threshold GOS.

For any given trunk group, the change can be caused either by a change in the basic demand for service or by a change in the network status. If the traffic level change is due to a change in network status, it would have been predictable based on network status parameters. No further information is obtained by observing that the traffic levels respond to the new network status.

If the traffic alarm thresholds are not changed, and the demand for service as well as the network status changes, there is no way to separate an alarm due to network status from an alarm due to traffic. Therefore, whenever the network status changes, the alarm thresholds for traffic monitoring should be modified so that they still relate to changes in the demand for service - i.e., they discount changes due to a changed network.

This modification of the threshold values can be accomplished by using a steady state model of the network to determine new nominal traffic values. Threshold offsets of some percentage can be applied to these traffic values. These expected traffic values and the resulting performance figures can be presented to the controller as further detail into what the status change means relative to network performance.

5.1.2 Equipment Status Parameters

The parameter attributes table for the TTC-39 equipment status parameters is shown in Table 5-3; that for the SB-3865 is shown in Table 5-4. The first three reports - equipment online, equipment standby, and equipment

TABLE 5-3. TTC-39 EQUIPMENT STATUS PARAMETERS

	SAMPLING INTERVAL	REAL TIME USE	LONG TERM ENGINEER USE	LEVEL OF VISIBILITY	COMMUNICATION FLOW (BITS/MESSAGES)	STRESS SENSITIVE TO
EVENT PARAMETERS						
R21 EQUIPMENT ONLINE	00[1]	X	X^2	AREA	216	SWITCH
R22 EQUIPMENT IN STANDBY	00	X	X^2	AREA	216	EQUIPMENT
R23 EQUIPMENT FAILED	00	X	X^2	AREA	216	FAILURE
R30 FAILURE/RESTORAL OF TRUNK GROUP CLUSTER	00	X	X^2	AREA	216	TRANSMISSION
R31 TRUNK GROUP LOSS OF SYNCHRONIZATION	00	X	X^2	AREA	216	SYSTEM
R52 TRUNK GROUP FIFO OVERFLOW	00	X	X^2	AREA	216	FAILURE
R60 INVALID ROUTE REQUEST	00	X		AREA	216	SYSTEM CONTROL ERROR
R64 AUTOMATIC LINE LOAD CONTROL IMPOSED	00	X	X^2	AREA	216	LOCAL TRAFFIC OVERLOAD
REAL TIME PARAMETER						
R27 TRUNK GROUP ERROR RATE	10 MIN.	X		AREA		
INFORMATIONAL PARAMETERS						
R2,2A TRUNK GROUP METERING	00		X	AREA	432	N.A.
R57 ROUTING TABLE ENTRY	00	X		AREA	216	N.A.
R58 SUBSCRIBER CLASS MARKS	00		X	AREA	216	N.A.
R64 MANUAL LINELOAD CONTROL	00	X		AREA	216	LOCAL TRAFFIC OVERLOAD
R65 ROVING SUBSCRIBER TABLE	00		X	AREA	216	N.A.
R67 TRUNKS ADDED/DELETED	00		X	AREA	216	N.A.
R68 SATELLITE CONTROL PARAMETERS	00		X	AREA	216	N.A.
R69 REPORTING PERIOD	00		X	AREA	216	N.A.
R70 ZONE RESTRICTION	00		X	AREA	216	N.A.
R71 AREA CODE RESTRICTION	00	X		AREA	216	N.A.
R72 NUMBER PLAN TRANSLATION	00		X	AREA	216	N.A.
R73 ALTERNATIVE AREA ROUTING	00		X	AREA	216	N.A.
STATUS PARAMETERS NOT CURRENTLY AVAILABLE						
TRUNK ROUTINING FAILURE	00	X		AREA	216	TRANSMISSION FAILURE
"RING AROUND THE ROSEY"	00	X		AREA	216	SYSTEM CONTROL ERROR
PROCESSOR UTILIZATION	10 MIN.	X		AREA		SWITCH OVERLOAD

NOTES 1. ON OCCURANCE

2. STATISTICAL SUMMARY

TABLE 5-4. SB-3865 EQUIPMENT STATUS PARAMETERS

	ICD-004 REPORT NUMBER	SAMPLING INTERVAL	REAL TIME USE	LONG TERM ENG USE	LEVEL OF VISIBILITY	COMMUNICATION FLOW NODE-SECTOR (BITS/MESSAGE)	SECTOR AREA (BITS/MESSAGE)	STRESS SENSITIVE TO	TRENDABLE
EVENT PARAMETERS									
EQUIPMENT ONLINE	21	00[1]	X	X[2]	AREA	216	216	SWITCH DEGRADATION/FAILURE	NO
EQUIPMENT IN STANDBY	22	00	X	X[2]	AREA	216	216	SWITCH DEGRADATION/FAILURE	NO
EQUIPMENT FAILED	23	00	X	X[2]	AREA	216	216	SWITCH DEGRADATION/FAILURE	NO
STATUS PARAMETERS NOT CURRENTLY AVAILABLE									
TRUNK ROUTINING FAILURE	XX	00	X		AREA	216	216	TRANSMISSION FAILURE	NO

NOTES: 1: "00" ON OCCURRENCE 2: STATISTICAL SUMMARY

failed - are generated any time there is a change in the status of the components of the TTC-39 or SB-3865. With the exception of pooled equipment failures when less than 25% of the equipments have failed, any occurrence of these messages is an immediately reportable HAZCON IAW DCAC 310-55-1. Therefore, these messages must be forwarded to area except when dealing with pooled equipment having less than a 25% reduction in capacity. Since most occurrences of these messages must be transmitted anyway, and there is currently no means to suppress those messages which are not required, it is reasonable to transmit R21, 22, and 23 whenever they occur. The thresholding of HAZCON status can be a function of the area level processor receiving these reports.

The next three reports listed all report on the loss of a trunk group, for various reasons. Reports of this nature are required by DCAC 310-55-1 on occurrence. In addition, DCAC 310-55-1 requires a report whenever 25% of any trunk group fails. There is no parameter supporting this requirement. A change in the software could be made to report, on occurrence, any trunk routining failure. This would satisfy the 55-1 requirements for the reporting of trunk failures and is recommended to be added to the list of TTC-39 and SB-3865 reports.

The invalid route request message is generated only when a call cannot be completed due to an error in a routing table somewhere. This error could affect critical subscriber communications and must be immediately corrected. The local switches do not have visibility of the entire network's routing

tables, so this function must be accomplished at a higher level. Therefore this report must be forwarded to the area level controller for action. Another type of routing table error with all the same implications is a "ring around the rosey" condition in which a call's partial route closes on itself. There is no report currently generated in this situation, and a change to the switch is needed to provide one. The R60 invalid route request message could be modified to support "ring around the rosey" conditions also by utilizing field A of the message (currently spare) to indicate which condition is being reported on.

The R64 report is listed in Table 5-3 twice, once under event parameters and once under informational parameters. It is listed this way because it occurs both as a consequence of automatic actions of the switch and as a result of direct operator action. In either case it is indicative of a local traffic overload situation such that local action has been taken to deny service to some routine users. This is an impaired service condition within the context of DCAC 310-55-1, so this report is needed at the area level in real time.

Two more parameters are listed as required for real time use - routing table entry and area code restriction. These reports reflect changes that the local switch supervisor has made in the call routing procedures followed by the switch. Changes in these procedures will cause a shift in network traffic load throughout the network. Furthermore, one of the major classes of control technique available to the area level controller is to modify

these procedures. Because of the network wide impact of a routing procedure change and the need to coordinate changes made from area with locally initiated changes, these parameters are required at area in real time.

The remaining set of informational parameters are items which typically would only be changed in response to a TSO. The reports generated are information which, under current procedures specified in DCAC 310-70-1, would be contained in an "in effect" report. These items are not needed in real time control, but they are required to be reported to the area level within 72 hours. In the normal operation of a network, the items reported on would change infrequently such that these parameters constitute a vanishingly small communication requirement. Since they are currently reported by the switch and a modification or an additional piece of equipment would have to be added to suppress their transmission, it is reasonable to allow these parameter reports to go to the area level.

An additional real time status parameter not currently available is recommended for addition to the switch-processor utilization. Under the TTC-39 software structure, self test and system control programs operate at absolutely the lowest priority. If for some reason the switch processor became overloaded, the system control programs might never get executed. During this situation, no reportable events can be detected. If processor utilization were available to the area controller, traffic shifts could be made under certain circumstances to insure adequate execution of system control programs. In a more general overload situation, the excessive

processor utilization figures could be used to suppress switch failure alarms when traffic reports become overdue.

5.1.3 Data Rate Requirement for the TTC-39

The data rate requirement between the TTC-39 and area has been established by considering a worst case scenario. This is necessary because the status parameters are transmitted only on occurance of a change in state. Each occurrance requires the transfer of 216 bits of information. A worst case message flow requirement can be established based on this and the traffic parameters previously selected, which will provide an overall telemetry needline. This will not allow apportioning a part of the needline to each parameter.

The worst case situation is that all traffic parameter reports queue up for transmission at identically the same time, and that immediately thereafter a status change occurs. A status report is at the same priority as a traffic report in the TTC-39 message priority hierarchy, so the status report would have to wait for all of the traffic reports. The maximum number of traffic reports from a TTC-39 is 31, broken down as follows:

1 R3 - Switch traffic status
9 R4 - Trunk group traffic status
9 R5 - Trunk group traffic status
5 R6 - Trunk group traffic status
1 R27 - Transmission group error rate
1 R44 - Switch traffic statistics
5 R47 - Switch traffic statistics

Therefore, a delay of up to 32 report transmissions can occur. If the maximum acceptable message delay is set at 1 minute, a 115.2 bps communication path is required.

Alternatively, if a 120 bps path is provided and messages arrive according to a Poisson distribution, the average message delay can be computed from basic queing theory results. The average data rate for traffic messages was previously shown to be 8.83 b/sec for the worst case European switch. The average time a message spends on the M/D/1 queue is

$$Tq = \frac{1/\mu}{2(1-e)} = \frac{1.8}{2(1-.072)} = .97 \text{ sec}$$

The average time until a message is received is

$$T = Tq + 1/ \;\; = 2.77 \text{ sec}$$

Based on these considerations, a reasonable communications needline from each TTC-39 switch to area is 120 bps.

5.1.4 <u>Data Rate Requirements for the SB-3865</u>

A similar worst case data rate can be developed for the SB-3865. If all the traffic parameters that can be recorded and relayed by the ULS queue up simultaneously just before a status change, the message queue for transmission to ACOC would be:

1 R3 - Switch Traffic Status

3 R4 - Trunk Group Traffic Status

2 R6 - Trunk Group Traffic Status

1 R44 - Switch Traffic Statistics

1 R21 - Equipment Online

1 R22 - Equipment Standby

1 R23 - Equipment Failed

Therefore, a delay of up to 8 report transmissions can occur. At 216 bits per report, a 28.8 bps communication path is required to keep the maximum dalay no greater than 1 minute.

5.2 AUTODIN II PARAMETER ANALYSIS

The CONUS AUTODIN II network has been specified and designed as a self-contained, self-managed system upon which WWOLS collects long term performance and near real-time status information. The functions and responsibilities of the DIN pieces and WWOLS have been partitioned as indicated in Figure 5-5 which is reproduced from the DIN II proposal on the following page. Because the European AUTODIN II network requires survivability in the event of isolation from CONUS, and because European WWOLS management requires full theater visibility, it is proposed that an SNCC (Sub-Network Control Center) be located in Vaihingen which has all the functional capability and resources of the NCC. In addition, all reports received by the SNCC must be forwarded to the CONUS NCC.

5.2.1 <u>Data Flow-PSN to SNCC</u>

The PSN's in Europe will generate 23 types of reports in three categories which are intended to keep the network management fully informed of network occurrences relating to:

MASTER CONTROL AREAS IDENTIFIED BY SPECIFICATION	CONTROL FUNCTIONS IDENTIFIED BY SPECIFICATION	INVOLVEMENT			
		WWOLS	NCC	P & TF	PSN
NETWORK CONTROL	NETWORK CONFIGURATION MONITORING	RECEIVES SUMMARY REPORTS	CONTINUOUS ASSESSMENT AND REPORTING	PROVIDE DATA	PROVIDE DATA
	DISTURBANCE DETECTION	RECEIVES SUMMARY REPORTS	ASSESSMENT AND REPORTING	PROVIDE DATA	PROVIDE DATA
	TRANSMISSION AND SWITCH RESTORAL	RECEIVES SUMMARY REPORT	COORDINATION AND DIRECTION	IMPLEMENTATION OF REROUTING AND RESTORAL	RESPONDS TO AVAILABLE ASSETS
	ADDITION/DELETION OF SUBSCRIBERS	AUTHORIZES ACTION AND RECEIVES VERIFICATION	COORDINATION AND DIRECTION AND REPORTING	IMPLEMENTATION	DIRECTED BY NCC OR PTF
	NETWORK RELATED SUBSCRIBER PROBLEMS	RECEIVES SUMMARY REPORT	ASSESSMENT, ISOLATION AND REPORTING	PROVIDE DATA	PROVIDE DATA
TRAFFIC AND ROUTING CONTROL	CONTROL OF TRAFFIC CONGESTION	NONE	LIMITED ASSISTANCE	NONE	CONTINUOUS REACTION TO NODE CONDITIONS
	ROUTING MODIFICATIONS	NONE	NONE	NONE	CONTINUOUS REACTION TO NODE CONDITIONS
PERFORMANCE ASSESSMENT AND STATUS MONITORING	CURRENT PERFORMANCE MONITORING	NONE	ASSEMBLES DATA AND DETERMINES PERFORMANCE	PROVIDE DATA	PROVIDE DATA
	LONG TERM PERFORMANCE	RECEIVES AND PROCESSES PERFORMANCE DATA	PROVIDES PERFORMANCE DATA	P & TF GENERATE SHORT TERM DATA ANALYZED AT THE NCC	PSN GENERATED SHORT TERM DATA ANALYZED AT THE NCC
BILLING DATA	BILLING DATA	RECEIVES ACCUMULATED BILLING DATA	COLLECTS, FORMATS AND REPORTS	NONE	PROVIDE DATA

Reference 7

Figure 5-5. AUTODIN II System Control Functions and Responsibilities

- Traffic volume-periodically and on demand
- Element status - on occurrence
- Billing-periodically

Appendix A contains a report, characterization of an AUTODIN II Node that summarizes the contents and purposes of each of these 23 reports.

5.2.2 Data Flow-SNCC to WWOLS

The information received in these reports feeds the NCC trending algorithms, the daily report generator programs and the WWOLS interface software. The information relayed to WWOLS is summarized in Table 5-5. The trending algorithms alert both the SNCC operator and WWOLS via the WWOLS output formatting routines (WOFR) of potential (TREND) or existing (FAILURE) failures or of the reversal of a previous TREND or FAILURE as functions of:

- Blockages recorded
- Preemptions
- Buffer utilization
- Processing delays
- Timeouts
- Retransmissions

In addition to passing on trending results, the WOFR also relay indications of unscheduled change of status of any:

- PSN
- Access line

TABLE 5-5. INFORMATION RELAYED FROM SNCC TO ACOC/WWOLS

Event	Report Frequency
1. Trending algorithm detects a TREND towards failure, or the reversal of a previous TREND.	On Occurrence
2. Trending algorithm detects a FAILURE, or the reversal of a previous FAILURE.	On Occurrence
3. STATUS Change o PSN Subsystem o Access Line o IST o Critical Switch Functions	On Occurrence
4. Program or table reload at a PSN	On Occurrence
5. Looping detected	On Occurrence
6. Interlace detected	On Occurrence

- o IST
- o Critical switch function
    - Switch buffering allocation
    - Source switch connection control
    - Source switch control for access denial
    - Destination switch timeout control
    - Switch directory table update
    - Switch outage and reload
    - Interlace detection

55-1 reports bearing this information are formatted on occurrence to keep ACOC fully informed of network and user status. Other information that must be relayed to maintain full cognizance at ACOC are:

- o Critical switch equipment status changes
- o Notice of program or table reloads
- o Looping detected Notices
- o Interlace detected notices

The DIN II spec states that the above information will be correlated and reduced by SNCC software such that WWOLS will receive only unique data from the SNCC. Because the SNCC is an entity distinct from the WWOLS computer complex, there is <u>no</u> steady state information flow rate between the SNCC and WWOLS. It is unreasonable, therefore, to attempt to size such a connection based on average information transfer. Rather, the worst case shall be considered.

This page intentionally left blank.

This page intentionally left blank.

Based on the information that will be reported in real time to WWOLS in a worst case scenario, the worst case would be either:

- o Loss of a link containing a group of DIN II access lines resulting in a 55-1 message for each access line.
- o PSN fails in such a way that the switch still operates but 5 critical switch functions not essential to the connection and forwarding of packets no longer work; results in 5 55-1 messages.

Assuming that a spur could contain as many as 15 or 20 subscribers, the former failure will generate more information. Assuming that all 20 subscribers are attached to the same PSN node, the failure reports will arrive serially within two minutes. The arrival of each Failure Report at the SNCC will spawn a 55-1 report addressed to WWOLS. Each 55-1 report consists of a 4 word header followed by S,K,U,E,Z and A content lines for a total of 10 lines at 16 bits per line or 160 bits per report. All failure reports must be delivered to WWOLS within 1 minute requiring 10 55-1 reports per minute. Therefore, the bit per second rate required to satisfy this worst case situation computes to:

$$\frac{(10 \text{ messages}) \times (160 \text{ bits/message})}{60 \text{ seconds}} = 26.7 \text{ bps}$$

5.3 ATEC PARAMETER ANALYSIS

The terrestrial parameters available from ATEC selected for ACOC visibility are listed in Table 5-6. The selection was based on the requirement for three types of data at ACOC:

1) Indications of stress conditions in the terrestrial DCS
2) Data indicating available transmission paths for restoring service
3) Data required to support the transmission system performance monitoring program.

The definition of stress conditions relative to the transmission system is that a link or trunk is out of service or is in a hazardous condition, or that a special interest circuit or a circuit serving a critical/high priority subscriber is out of service. The ATEC 10000 specification defines fault isolation functions for the Nodal and Sector Control Subsystems. The parameters required will be a summary of the results of these isolation algorithms formatted for transmission to ACOC. The fault isolation algorithms will be initiated for trunk and link outages by alarms in the transmission system. Thus, this fault indication will come soon after a fault occurs. Circuit level outages will be identified by results of in-service monitoring or subscriber queries. The delay to such an indication can be considerably longer than the delay to a trunk or link outage indication. Thus, other sources could detect the outage sooner than in-service monitoring.

Results of fault isolation algorithms will be forwarded as soon as they are available via an initial fault report, thus permiting immediate notification of ACOC of any major problem. ACOC can then assess system status with up to date information, instead of having information delayed ten minutes as

TABLE 5-6. ATEC PARAMETERS

PARAMETERS	SAMPLING INTERVAL (MIN)	CONTROL USE	LONG TERM ENGINEERING USE	LEVEL OF VISIBILITY	PER SECTOR COMMUNICATION FLOW #MSGS/DAY	CHARAC/[2] MSG.	SECTOR/AREA (BITS/DAY)	STRESS SENSITIVE TO	TRENDABLE
CIRCUIT LEVEL[1] INITIAL FAULT REPORTS	ON CHANGE	YES	YES	ACOC AND BELOW	150	83	99,600	CIRCUIT LEND FAULT	NO
CIRCUIT LEVEL FOLLOW UP FAULT REPORTS	ON CHANGE	YES	YES	ACOC AND BELOW	235	103	193,640	N.A.	N.A.
TRUNK, LINK, STATION[1] INITIAL FAULT REPORTS	ON CHANGE	YES	YES	ACOC AND BELOW	28	83	18,592	TRUNK, LINK OR STATION	NO
TRUNK, LINK, STATION FOLLOW UP FAULT REPORTS	ON CHANGE	YES	YES	ACOC AND BELOW	42	103	34,608	N.A.	N.A.
DAILY REPORTS	DAILY	NO	YES	ACOC AND BELOW	(SEE TEXT)		84,000	N.A.	N.A.
CONNECTIVITY UPDATE	ON CHANGE	YES	NO	ACOC AND BELOW	(SEE TEXT)		125,272	N.A.	N.A.
RSL SUMMARY	MONTHLY	NO	YES	ACOC AND BELOW			84 BYTES/ LINK/MONTH	DEGRADING LINE	YES
BB DEGRADATION SUMMARY	MONTHLY	NO	YES	ACOC AND BELOW			84 BYTES/ LINK/MONTH	DEGRADING LINK	YES
SECONDS OF DEGRADATION	MONTHLY	NO	YES	ACOC AND BELOW			84 BYTES/ LINK/MONTH	DEGRADING LINK	YES
XMTR OUTPUT SUMMARY	MONTHLY	NO	YES	ACOC AND BELOW			84 BYTES/ LINK/MONTH	DEGRADING LINK	YES
						TOTAL	556,072 BITS/DAY 6.44 BITS/SECOND		

1 ALARM CORRELATION IN ATEC IS ASSUMED TO HAVE INHIBITED TRANSFERRING OF TRUNK OR CIRCUIT STATUS IF THEY ARE CAUSED BY A HIGHER FAULT LEVEL.

2 8 BIT CHARACTERS PER ATEC FORMATTING

currently provided by 310-55-1. Thus, ACOC will at least know what is happening, if not why. Then in 10 minutes, the details will be forwarded and appended to the initial report, as currently required for 310-55-1 requirements. This is referred to here as a follow up fault report.

The benefits of making a partial report immediately are:

a) It provides a total picture of theatre connectivity status at ACOC immediately, thereby assisting the process of reconstituting the network.

b) If ACOC is responding to one major outage, the latest data on the remainder of the system will be available. This will facilitate dynamic rerouting algorithms being directed from ACOC.

The negative aspects of forwarding status information without human editing includes the fact that ACOC personnel may tend to request additional data from the sector, thereby hindering its response to the problem. However, the requirement to complete fault isolation before forwarding the message to ACOC provides a filter assuring that the fault is of at least several minutes in duration.

The amount of data to transmit was determined to be 60 characters (83 with ATEC format overhead) for the initial fault isolation message and 80 characters (103 with ATEC format overhead) for the follow up report.
See Figure 5-6.

The number of reports to ACOC per day is based on data from references 28 and 29. The first reference indicated that 20% of the circuits throughout Europe have faults on a given day. Assuming a node having responsibility for some 2,000 circuits, there would be 400 faults

Initial Outage Report

Fault Report	4 characters	
Circuit ID	9 characters or Link ID or Trunk ID	
Submitting Node	4 characters	
Terminating Locations	8 characters	
Location of Fault	4 characters	
Time Out, Zulu	8 characters	
Degree of Degradation	3 characters	
Cause of Fault	20 characters	(computer generated)
	60 characters	

Follow up Report

Fault Report #	4 characters	
Reference Initial Report #	4 characters	
Submitting Node	4 characters	
Location of Fault	4 characters	
Time of this Report	8 characters	
Degree of Degradation	3 characters	
ETR	4 characters	
Narrative Field	59 characters	(sized to fit ATEC 80 character format
	80 characters	

Each field includes spaces to separate fields.

Figure 5-6. Contents of Initial and Follow up Reports

per day per node. However, these would not all be reportable. The second reference indicates that there are approximately 30 reported on and 120 unreportable outages at a major node per day, and a like amount for a typical five sites reporting to the node. Thus, this indicates that there are some 300 faults per day. These two references agree reasonably well. The reporting approach described above will yield 30 reportable faults per node requiring an initial report, a follow up report and a closing follow up report, or 90 reports from each node.

In addition, there would be some number of the ultimately non-reportable faults which would be forwarded to ACOC because the current 10 minute delay has been rescinded. This number is estimated to be another 30, which will have an initial report and one closing follow up report since the fault was not long enough to be reportable per 55-1 requirements. Thus, there are 150 reports per node. There are three sectors with three nodes accounting for 450 reports per sector and one with two nodes accounting for 300 reports, of which 180 and 120 are initial reports and 270 and 180 are follow up reports. An average number of 150 initial and 235 follow up reports has been used.

The second reference indicates that there are also:

- o 2 station outages
- o 12 trunk outages
- o 4 link outages
- o 35 channel outages

53 total

daily throughout the European theatre which are also reportable. There will again be a number of events which occur which are not ultimately reportable but cause initial fault reports and closing follow up reports. This number is also assumed to be 53. For each of the four secotrs, there will be approximately 14 ultimately reportable events, requiring 14 initial, 14 follow up and 14 closing follow up reports, and 14 ultimately not reportable events requiring 14 initial and 14 closing follow up reports, or 28 initial and 42 follow up reports.

The 55-1 daily report is also assumed to be forwarded over the ATEC-WWOLS telemetry path. This is logical since the 55-1 daily report will be collected from the individual fault reports developed both automatically by the ATEC system and by the operator interacting with the ATEC system. The size of this transfer is estimated to be an average of 18,000 characters per sector. This is found by using the estimate of 30 reportable outages per node per day, 3.5 nodes per sector, and 100 characters per event This yields 105,000 characters or 840,000 bits per day.

The data required to indicate available transmission paths for restoral of service includes that discussed above (i.e., outage information), as well as status of the individual low priority circuits. I.e., potentially any change of status of any circuit should be reported on occurrence. However, the selected alternative to this is for the ACOC to request status of low priority circuits which are reroute candidates from the sector in which the circuit terminates. This reduces the size of the data flow and the amount of data base updating at ACOC. The digital backbone will typically not be the cause of a single curcuit outage. Instead, the user tail or user instrument will cause such a problem. Thus, if the trunk is in service, the backbone segments of the circuit will generally be usable for altrouting.

AD-A080 765 HONEYWELL SYSTEMS AND RESEARCH CENTER MINNEAPOLIS MN F/6 17/2
SYSTEM CONTROL FOR THE TRANSITIONAL DCS.(U)
DEC 78 F C ANNAND, M F BURKE, R K CROWE DCA100-78-C-0017
UNCLASSIFIED TR-2 SBIE-AD-E100 326 NL

4 OF 4
AD A
080765

END
DATE
FILMED
3-80
DDC

Therefore, the response to the status query should distinguish between backbone and user tail problems, which the RFO code will do.

Additional data required to maintain visibility of resources available for restoring service is the altrouting selected at the Sectors or Nodes. This requires that altroute information be transmitted to ACOC on occurrence. This is referred to as "connectivity updates". For a link outage, 20 percent or 77 or the circuits of a 384 channel link are assumed to be rerouted. This is the percentage of circuits in Europe which are priority 1 and 2. Only for extended outages would rerouting occur. This would be the number of reportable outages, assumed to be 4 per day or 1 per sector. Thus, there would be 77 reroutes attributed to link failures per sector per day. It is assumed that 20 characters are required for each circuit restoral. Packing these into an ATEC message with 80 text characters per 103 transmission characters (29% overhead) requires 1.29 x 77 x 20 = 1987 characters per day.

The number of reports due to the two station outages per theatre per day would depend on the site of the station . By assuming it to have three links, then some of the circuits will pass over two of the links. The total number of circuits involved might be equivalent to 1.5 links. Ascribing one station outage to a sector, another (1.5) x 1987 characters (based on the link outage), or 2980 characters are required.

For the 12 reportable outages of 24 channel trunks per theatre (3 per sector) per day, we have 0.2 channel restorals/channel x 24 channels/ trunk x 3 trunk outages/day x 20 characters/outage x 1.29 overhead factor = 372 characters/day.

The 240 reportable circuit level outages per sector per day would all be candidates for alt routing. One ATEC message would be required for each of these alt routes. This message would again require 20 characters (10 to identify the circuit restored and 10 to identify the circuit preempted) but the overhead, an added 23 characters, is now 115%. Thus, we require 240 connectivity changes x 20 characters/messages x 2.15 overhead factor = 10,320 characters. For all four connectivity update types, there will be 1987 + 2980 + 372 + 10,320 = 15,659 characters/day.

The data currently required for the performance monitoring program (PMP) is specified in DCA circular 310-70-1. It includes:

- o Idle Channel Noise
- o Received Signal Level
- o Base Band Loading
- o Impulse Noise

These readings are submitted on the Q-line of the 55-1 daily report. The transition to a digital transmission system will result in a change in the parameters necessary for the PMP. The ATEC 10000 specification, as cited below, requires that hourly reports of the following parameters to be used for performance monitoring, be generated by the station:

- o Mean and lowest received signal level (3.2.1.1.4)
- o Baseband degradation parameters corresponding to mean and highest degradation (3.2.1.1.4)
- o Counts of seconds which experienced degraded RSL, degraded/ baseband, first or second level multiplexer degredation, and

channel degradation (3.2.1.1.4)

o Measured transmitter output power parameters (3.2.1.1.5.1.2)

These parameters are in turn to be processed at the Node and Sector to calculate mean and standard deviations for the last 24 hours, 7 days, or 30 days. It is recommended that they be forwarded to ACOC to be collected into the long term performance assessment files. This collection can be done every 30 days because the ATEC system will retain the data for that period of time.

Other parameters can be collected into history files in ATEC if desired. The list of data to be collected is programmable at the NCS/SCS. Thus, if special data is required for a special purpose, it can be collected and forwarded to ACOC in a similar manner to the specified performance assessment parameters.

The total transfer per day (ignoring the summary data, which is an inconsequential contribution) yields 6.44 bits per second.

To obtain a worst case estimate of the required communications flow, a worst case scenario has been defined, and the resultant comm flow requirement sized. The worst case would consist of a number of unrelated events occurring within a sector, all of which must be reported to ACOC. Since alarm cascading is assumed to be suppressed by ATEC, only one message resulting from each outage will be issued to ACOC.

If fault isolation is completed before a message is sent to ACOC, then

any node would have only one message to be transmitted at a time. The rest would be delayed by awaiting their turn to go through the fault isolation processing. At the sector, messages from up to four nodes (the size of the biggest sector in Europe) would be ready simultaneously. If each message were 100 characters, there would be 400 characters to transmit.

Establishing a time frame for telemetry to ACOC of say, 10 seconds, a 40 character or 400 bit/second (assuming 10 bits/character) line is required. However, this ignores any delays due to processing or awaiting processing.

Another large user of the telemetry path for ATEC will be the connectivity updates. These updates will document changes in connectivity resulting from temporary rerouting. In the case of an entire link being out of service, there will be a large number of connectivity changes occurring. If we assume that 20 percent of the circuits on the link will be rerouted (equivalent to the overall percentage of intra European circuits which are priorities 1 and 2), then 77 circuits will be rerouted, at worst affecting 77 other circuits which have been preempted. In this case, there will be a listing of circuits restored and circuits preempted using approximately 10 characters for each circuit. Thus, (77 circuits restored + 77 circuits preempted) x 10 characters/circuits = 1540 characters, or 15,400 bits will be transmitted.

The need for this message is to prevent attempted reuse of the same

circuits for another restoral. If the preempted circuits are identified in several minutes, this should minimize excessive attempts to reuse the same circuit. Establishing an objective of two minutes for transferring the 15,400 bits yields 128 bits/second.

These are the only data transfers which are time critical for the transmission system.

5.4 DSCS PARAMETER SELECTION

Selected DSCS CS Parameters must be reported to both the ATEC node and the ACOC. The recommended parameters provide visibility of major outages (trunk and link outages). This permits identifying critical subscribers impacted by the outage via data base searches at ACOC and the Node. It also provides a summary status of major connectivity paths which may be of use in restoring service due to an interruption elsewhere in the system. In addition, parameters which are anticipated to be useful for long term performance assessment of the DSCS are included. In this case, parameter summaries beyond those recommended in the Control Segment Specifications are included. Specifically, EIRP, received signal strength, and estimated frequency errors are required.

The selection of parameters was based on a parameter list derived from the DSCS CS specifications. The appendices describing the data bases were not available. The recommended parameters for ACOC visibility are listed in Table 5-7, with further details in Table 5-8. The total list of parameters from which these were selected are contained in Tables

TABLE 5-7. DATA FLOW, NCE/WWOLS

	CONTROL	LONG TERM	TRENDABLE	STRESS SENSITIVE TO	INTERVAL	MESSAGES/ DAY	CHARACTERS/ MESSAGES	BITS/ DAY
1. LINK PERFORMANCE ASSESSMENT, INITIAL REPORT	X		NO	SATELLITE	BY EXCEPTION	2	83	166
2. LINK PERFORMANCE ASSESSMENT, FOLLOW UP REPORT	X	NO		TRANSMISSION SYSTEM FAILURE	BY EXCEPTION	4	103	412
3. LINK PERFORMANCE SUMMARY		X	NO		24 HOURS	30	83	2490
4. EQUIPMENT STATUS, INITIAL REPORT	X	X	NO		ON CHANGE	150	83	12450
5. EQUIPMENT STATUS, FOLLOW UP REPORT	X	X	NO		ON CHANGE	225	103	23175
6. CALIBRATION DATA		X	NO		24 HR SUMMARY	150	48	28800
7. ALARM MESSAGES	X		NO		ON OCCURRENCE	----	----	----
8. TEXT MESSAGE	X		NO		ON OCCURRENCE	30	250	60000
9. CONFIGURATION UPDATES	X		NO	N/A	ON OCCURRENCE	20	100	2000
10. SPARE RESOURCES	X		NO	N/A	ON CHANGE	60	46	2760

132253 BITS/DAY
1.53 BITS/SECOND

TABLE 5-8. DETAILS OF DSCS EQUIPMENT STATUS, OCE/WWOLS

	Control	Long Term	Trendable	Stress Sensitive To	Interval
Terminal Equipment					
- Operational Status of Major Units	X	X	NO	Media, Terminal Link	On Change
- ETR	X			-	On Change
Digital Communications Subsystem					
- Operational Status of Each Major Device	X	X		Link Outage	On Change
- ETR	X			-	On Change
Spread Spectrum Modulation Equip.					
- Operational Status of Each Major Device	X	X		SS Channel Outage	On Change
- ETR	X			-	On Change
Control Orderwire Slave					
- Operational Status	X	X		Control Segment	On Change
- ETR	X			-	-

5-9, 5-10, and 5-11. Table 5-9 lists the status and performance parameters available from the NCD and the TCE. Table 5-10 lists the configuration data which is updated by the NCE. Table 5-11 lists the details of the status data. The recommended parameters to be sent to the node are listed in Table 5-12.

The analysis leading to the recommended parameter list (Tables 5-7 and 5-8) is discussed below. Following that is a discussion of how the required data rates were estimated.

Link Performance. This parameter is recommended for real time control because it indicates the ability of the DSCS link to carry traffic. The parameter will be reported to ACOC and to the responsible ATEC Node only when it exceeds specified thresholds indicating that performance is marginal or completely unuseable. These conditions may cause alarms in the CS, but the types of alarms are not identified in the CS documentation. The parameter is trendable in the sense of setting a threshold to indicate marginal performance. Application of short term derivatives is not recommended. An historical profile of the parameter is already specified. (i.e., link performance summary.) The ACOC or Nodal data base will be used to identify circuits impacted by the loss or degradation of service.

Link Performance Summary. This parameter is used at the ACOC for long term engineering. It is selected as a contributer to performance monitoring of DSCS. It is not trendable.

TABLE 5-9. SUMMARY OF STATUS AND PERFORMANCE PARAMETERS AVAILABLE (DSCS CS)

Data Parameter	Source	Used For Long Term Eng.	Used For Control	Trendable (rel. ACOC)	HP	Stress Sensitive To	Interval
Link Performance	TCE		NCE,OCE,ACOC	NO (?)	(0)	Eqpt or media	By Exception(1/ Min. from TCE)
Link Performance Summary	TCE	OCE,ACOC	NCE,OCE,	NO	YES	N.A.	24 Hours
Uplink Power Margin	TCE		NCE	(0)	(0)	Eqpt or media	
Downlink Power Margin	NCE		NCE	(0)	(0)	Eqpt or media	
Channel Quality	TCE		NCE	NO	NO	Channel Degrad.	
Digital Subsystem Status	TCE		NCE,OCE,ACOC	NO	YES	Eqpt.	On Change
SSME Status	TCE		NCE,OCE,ACOC				On Change*
Control Orderwire Slave Status	TCE		NCE,TCE				
Terminal Equipment General Status	TCE		NCE,OCE,ACOC				On Change*
Calibration and Test Subsystem Status	TCE		NCE,TCE		YES	Eqpt.	On Change*
Control Orderwire Slave Status	TCE		NCE,TCE		NO	N.A.	
Calibration Settings	NCE		NCE,TCE	NO	NO	N.A.	
Enabled Alarms	TCE		NCE,OCE,ACOC	NO	NO	Eqpt. or media	On Change
Text Message	TCE		NCE,OCE,ACOC	NO	NO	N.A.	As Required
Alarm Message	TCE	Relationship to Enabled Alarms not specified					

(0) Need obviated by other measures.

HP Historical Profile

* Recommended once/10 minutes in CS specification.

\+ Summary

TABLE 5-10. SUMMARY OF CONFIGURATION DATA/CONFIGURATION CONTROL (DSCS [illegible])

Data Item	Source	Used for Planning	Used for Control	Interval
Terrestrial Channel Configuration Control Updates	NCE	ACOC	NCE, OCE, ACOC	On Change
- Identification				
- Data Rate				
- Destination/Origin				
- Priority				
- Dynamic Service Cat.				
- Trunk Assignment				
- Security Level				
- Required BGR				
- Dynamic Service Category				
Multiplexer Configuration Updates			NCE, OCE, ACOC	On Change
- I/O Rates by Channel				
- No. of Unused Channels				
- Priority Level Available				
Modem/Coding Configuration Updates			NCE	On Change
SSME Configuration Updates		ACOC	NCE	On Change
Control Orderwire Subystem Updates		NCE	NCE	On Change
- Control Orderwire Slave Conf.		NCE		
Terminal Equipment Conf. Updates		ACOC	NCE	On Change
- Up/Down Converters				
- High Power Amplifier				
- Beacon Receiver		ACOC		
Calibration and Test Configuration		NCE	NCE	On Change
COMSEC Configuration Updates		ACOC	NCE	On Change
Link Establishment Data		NCE	TCE's	As Required
- User Circuit/Trunks				
- Terminal Equipment				
- Trunk Quality				
- Satellite Parameters				

TABLE 5-11. DETAILED STATUS LISTING

Details of Status Data	Source	Used For Long Term Eng. (Level)	Used For Control (Level)	Trendable (rel. ACOC)	Stress Sensitive To	Interval
Digital Communications Subsystem (DCSS) Status	-	-	-	-	-	-
Multiplexer overhead channel error rate	TCE	NO	NCE	NO	Degrad. Media	-
Multiplexer sync	TCE	NO	NCE		or equipment	-
Modem trunk estimated error rate	TCE	NO	NCE			-
Modem receiver sync	TCE	NO	NCE			-
COMSEC sync	TCE	NO	NCE			-
Operational status of each major device, i.e. multiplexer, modem, CODEC, etc.	TCE	OCE,ACOC	NCE,OCE,ACOC	NO	Failed Equip.	On Change
Time to restore for all failed units	TCE	NO	NCE,OCE,ACOC	NO	NONE	On Change
Spread Spectrum Modulation Equipment (SSME) Status						
Estimated error rate on each received signal	TCE	NO	NCE	NO	Degrad. Media	-
Estimated received signal strength	TCE	NO	NCE	NO	or equipment	-
Receiver sync, each received signal	TCE	NO	NCE	NO		-
Satellite range and range rate vs time	TCE	NO	NCE	NO		-
Operational status	TCE	NO	NCE,OCE,ACOC	NO		On Change
Control Orderwire Slave (COS) Status						
Time and length of all TTY trans. and receptions	TCE	NCE,OCE	NO	NO	NONE	-
Time and length of all HSD trans. and receptions	TCE	NCE,OCE	NO	NO	NONE	-
HSD received block error rate	TCE	NO	NCE	NO	HSD Degradation	-
HSD transmitted block retransmissions and receptions	TCE	NO	NCE	NO	HSD Degradation	-

TABLE 5-11. DETAILED STATUS LISTING

	Source	Used For Long Term Eng. (Level)	Used For Control (Level)	Trendable (rel.ACOC)	HP	Stress Sensitive To	Interval
CMC received block error rate	TCE	NO	NCE	NO		CMC Degradation	-
CMC transmitted blk. transmission rate	TCE	NO	NCE	NO		CMC Degradation	-
Received signal strength on broadcast channel	TCE	NCE,OCE	NCE	NO		NONE	-
Received error rate on broadcast channel	TCE	NCE,OCE	NCE	NO		NONE	-
Poll-back channel EIRP	TCE	NCE,OCE	NCE	NO		NONE	-
Operational status	TCE	NCE,OCE	NCE,OCE,ACOC	NO		NONE	-
<u>Terminal Equipment</u>							
Operational status of all major units	TCE	NCE,OCE,ACOC	NCE,OCE,ACOC	NO	YES	Equip. Failure	On Change
Estimated restore time for all failed units	TCE	NO	NCE,OCE,ACOC	NO	NO	N.A.	On Change
GMT Time in sec. accurate to better than 10 milliseconds	TCE	NO	NO	NO	NO	N.A.	-
<u>Calibration Data</u>							
Received C/kT on each downlink	TCE	NCE,OCE,ACOC	NCE	NO	YES	Equip. Degradation or Failure Operating Anomaly	Daily Summary Collected, Available on Demand
Transmit EIRP on each uplink	TCE		NCE	NO	YES		
Estimated satellite beacon frequency error	TCE		NCE	NO	YES		
Estimated satellite translator freq. error	TCE		NCE	NO	YES		
Received pilot signal strength, all terminals	TCE		NCE	NO	YES		
Estimated one way doppler	TCE	NCE	NCE	NO	YES		
Difference between expected and received pilot signal strength, all terminals	TCE		NCE	NO	YES		
Difference between expected and received beacon signal strength, all terminals	TCE		NCE	NO	YES		

TABLE 5-12. DATA FLOW TCP/CIS

	Control	Long Term	Trendable	Stress Sensitive To	Interval	Messages/Day	Characters/ Messages	Bits/Day
1. Link Performance Assessment, Initial Report	X		No	Satellite	By Exception	1	83	83
2. Link Performance Assessment, Follow up Report	X		No		By Exception	2	103	206
3. Equipment Status[1], Initial Report	X	X	No	System	On Change	30	83	2490
4. Equipment Status, Follow up Report	X	X	No		On Change	45	103	4635
5. Text Message	X		No		On Occurrence	6	250	1500
								8914 bits/day .10 bits/second

1 - See Detailed Status List, Table

Uplink Power Margin. Used for real time control at the NCE level. Link Performance assessment provides a summary which eliminates the need of this parameter above it.

Downlink Power Margin. Used for real time control at the NCE level. Link Performance assessment provides a summary which eliminates the need of this parameter above it.

Channel Quality. Monitoring channel quality is a technical control function. It is of concern at the ACOC or Node when users are out of service. It is assumed here that user to user channel monitoring will occur in the terrestrial transmission system and therefore obviate the need to report this to ACOC or the Node.

Digital Subsystem Status, SSME Status, Terminal Equipment Status. Overall operational status and time to restore for equipment that causes a user outage or a HAZCON must be sent to ACOC and to the ATEC Node. This information must be reported in terms of what circuit, trunk or link is impacted, since neither ACOC or the Node have a data base relating equipment to circuit, trunk or link. It is assumed that the individual error rates, synynchonization indicators, and such are processed with the DSCS CS so that the actual cause of any of these statuses being out of tolerance is detected and this is passed to ACOC as an RFO code. Therefore, the remainder of the entries in these categories are not selected.

Control Orderwire Slave (COS) Status. The Control Orderwire Slave is the normal TCE interface to the NCE. The operational status is of interest at ACOC because it indicates that the TCE is not accessible to the NCE, and therefore that the system responsiveness is reduced. If the COS is out of service, either the Critical Control Circuit (CCC) or the Orderwire to the terrestrial DCS must be used to report this event.

Calibration Data. All of this data is indicative of details of the performance of the DSCS rather than the go/no-go performance indications for system resources. The go/no-go indications are available via other parameters, e.g. link performance assessment, channel quality, synchronization of receivers and multiplexers, etc. Therefore, these parameters are not useful for real time control at the ACOC or Nodal level.

Some of them are needed as indicators of long term performance of the DSCS and should be reported to ACOC. The link performance assessment data alone can indicate whether or not the link is performing per specification. However, analysis of what each component of the system contributes to the overall link performance is possible only through these parameters. For example, only by knowing the received C/KT and transmit EIRP for a link can the contributions of each segment of a link to overall link performance be analyzed. In other words, the actual system attributes required

to meet the link performance assessment goal can be identified. The pilot signal strength can also be of use in such an analysis. The frequency error data will allow performance analysis of the timing systems throughout the DSCS. In both of these cases, multiple components of the DSCS are involved. Thus, these items are recommended for use in long term engineering. They will be of use at ACOC or DCAOC. However, their historical summary might be retained in OCE or NCE data bases and accessed as needed. Daily summaries of these parameters are appropriate, i.e., the smallest and largest values.

The estimated doppler, the difference between expected and received pilot signal strengths, and the difference between expected and received beacon signal strength are not necessary for system wide long term engineering because they primarily reveal information about the local facility rather than about overall system performance. Specifically, the estimated doppler depends on the actual satellite movement and the local calibration equipment. The satellite movement is being controlled by the SCCE so that data about it from this terminal is unnecessary. The differences in signal strength are primarily due to local weather conditions. The NCE uses this data for adjusting transmitter power allocations in real time. This data reflects temporary environmental conditions rather than long term system performance, and is therefore not useful for long term assessment.

Calibration Data Settings. This is information supplied to the terminal to operate the calibration and test subsystem. It does not give information on system performance and is therefore not of interest.

Enabled Alarms. The enabled alarms are unspecified. They are discussed in reference SS-TCE-140, page 21. It is presumed that they are results of violating performance thresholds, losses of sync, and similar phemonenon. These phenomena have been accounted for in equipment status and link performance assessment. If there are other alarms that cause interruptions of subscribers, they must also be transmitted to ACOC. They must be related to the CCSD, trunk or link which they affect.

Alarm Message. This is also found in reference SS-TCE-140, page 21. The relationship of this to alarms is unspecified. It could be the description of the cause of the alarm, discussed in the alarm paragraph. It has been ignored.

Text Message. It is assumed that this is used for coordination. Therefore, it is specified to be used as required.

Configuration Data. The configuration data (see Table D-4) maintained by the NCE and TCE includes parameters necessary to identify the multiplex hierarchy in the Earth Terminal, the circuit assignment

of each channel, and the specific type, priority, quality, etc., of each channel or trunk. This is described in reference SS-TCE-140, page 13. Updates issued by the TCE or NCE will be sent to ACOC as confirmation of a TSO or as indication of a temporary deviation from the normal configuration. This is consistent with the practice of keeping the DOCC connectivity data base up to date, as well as providing the data necessary to rapidly identify availability of resources for altrouting.

DSCS Control Segment Data Rate Requirements

The interfaces of concern relative to the DSCS Control Segment are those defined to support system level System Control, i.e., the NCE/WWOLS interface and the TCE/CIS interface. The parameters are listed in Table . The development of bit rates required for them is discussed in the following paragraphs.

The current Link Performance Assessment is transmitted to ACOC whenever the performance is out of specification. i.e., whenever the link is degraded or out of service. By the mid 1980's, the Atlantic and Indian Ocean satellites, which are the primary suppliers of satellite service to the European theatre, will support 20 to 40 DCS links each. There will also be non-DCS links.

NCE will presumably be monitoring the performance of these links to assure that they are operating per requirements. (This may in fact be done by subnet controllers who ask for service from the NCE only when they determine

that action is required.) The OCE and WWOLS concern with the non-DCS users is only what satellite resources they use which might be used by the DCS in a contingency. Therefore, only performance of the DCS links will be sent to OCE/WWOLS. There would be expected to be only about two DCS link problems per day per satellite/NCE. The message would be similar to that for a terrestrial fault, about 60 characters plus overhead for the initial and 80 characters plus overhead for two follow up reports.

The link performance summary will require one message per link per day, or approximately 30 messages per NCE. This is also assumed to be about 60 characters plus overhead.

Equipment status will be reported on an exception basis. There are five DCS terminals in Europe. (See the deployment model in the first report.)

However, the NCE is actually concerned with all of the Earth Terminals serviced by its satellite. Therefore, there will be probably 15 or more terminals for each NCE on which to report equipment status. Of these terminals, only the fault reports on those in the European theatre, used by the DCS, will be of interest to ACOC Europe. Those terminals used by the DCS but in other theatres will ultimately be of interst to DCAOC or ACOC-Pacific. Their status can be reported to DCAOC or ACOC-Pacific over direct communication paths from the NCEs ot DCAOC or ACOC-Pacific. Alternatively, the data can be sent to ACOC-Europe and forwarded. Because paths are planned between each NCE and all ACOC or DCAOC locations served, the direct path

is preferred. Thus, only status of the five European DCS terminals will be reported to ACOC-Europe.

The quantity of equipment status reports depends on the amount of equipment at the site. Typically, a terminal will have individual circuit appearances using a relatively large amount of equipment. If this is likened to a terrestrial DCS Node, then 30 reportable faults per day would again be expected. However, there will probably be fewer circuits with user tails homed on the site, since the terminals are not in areas of subscriber concentration, nor do they usually have collocated VON switches. Thus, it is estimated that there will be about 15 reportable faults per day, yielding 15 initial, 15 follow up, and 15 closing follow up reports. For reports that are not reportable, the estimate of 15 initial and 15 closing follow up reports will be applied, as for the terrestrial system. For the five European terminals, used by the DCS, this amounts to 5 x (30 initial fault reports + 45 follow up fault reports). The ATEC message sizes of 83 and 103 characters, respectively, are applied. Calibration data might also be referred to as performance assessment data. Twenty-four hour summaries of five selected calibration data items are forwarded to ACOC. Two of these are link parameter, and three are terminal parameters. If all links and terminals are reported to one ACOC, then for (an estimated) 30 links, 60 reports must be sent, and for 15 terminals, 45 reports must be sent. The report must contain the following:

- o resource identifier (link or terminal) - 6 characters
- o parameter identifier - 10 characters
- o maximum value - 10 characters
- o minimum value - 10 characters
- o reporting facility - 4 characters (3 letter site identifier plus 1 letter to identify it as an NCE)
- o Total - 40 characters
- o Total with overhead - 48 characters

Thus, the NCE will contribute 75 reports x 48 characters or 3600 characters/ day.

The alarm messages are assumed to be elaboration on any performance assessment violations or equipment status. Thus, they were accounted for in those categories.

Text messages are assumed to be coordination and resource allocation related. At the NCE/OCE/WWOLS interface, there will be little interaction other than for resource allocation. It is expected that no more than 20% of the faults would require communication via text messages. Thus, the 150 daily faults reported to ACOC would yield 30 text message interchanges. Sizing these at 250 characters each (a liberal narrative message size) another 7500 characters per day (toward ACOC) are required.

The most frequent configuration updates for DSCS will be at the channel, multiplexer or link levels. For temporary changes in the configuration,

an update of all items listed in Table (configuration updates) is not required. Typically what will happen is that a new link or multiplex group will be established to serve a short term requirement. Or, the circuit assigned to one channel will be pre-empted to permit that channel to carry a different circuit. This latter case is more appropriately handled in the terrestrial system. In the event that jamming occurs, a message will be sent listing the circuits which have been pre-empted or the message will state that a specified plan has been implemented. Since the reaction to jamming is expected to be preplanned, and the latter technique simplifies the message, that technique is recommended.

Thus, the configuration updates are in the areas of:

- new links
- new multiplex groups
- notification of implementation of jamming countermeasures

There will be relatively few such transmissions. An estimate of two temporary links, two temporary multiplex groups, and no counter measures will be assumed to occur per day in one-satellite terminal. These would be typically a 100 character or less message. Thus, four 100 character messages per terminal would be required. For the five DCS terminals in Europe, there could be 20 such messages.

The spare resources messages will occur whenever there is a change in the overall system. Extending the estimated two link and two multiplex group changes per terminal per day, fifteen terminal network would yield sixty such resource changes per day. The message will contain approximately the following information:

- o Date and Time - 7 characters
- o Satellite ID - 4 characters
- o Transponder IF - 4 characters
- o Bandwidth Utilized - 4 characters
- o Power Utilized - 4 characters
- o Total - 23 characters
- Overhead - 23 characters

46 characters

Totaling all of the data types, the average flow is 1.5 bits/second.

A worse case scenario would more usefully size the transfer rate requirement. For example, if it was desired to establish new links, an exchange involving several transfers of messages each direction might occur.

It is assumed that this is a 250 character text messages. Simultaneously, status messages and link performance messages might be queued up. Let there be five such messages, for 515 characters (all follow up reports).

A total transaction of sending a text message and receiving a response (i.e., an acknowledgment that the message is being responded) should take a maximum of 30 seconds. Allowing ten seconds for the transfer in one direction would require that the (250 + 515) characters be passed in ten seconds, assuming a single first in first out queue with the message at the end of the queue. This results in a 612 bps rate requirements.

The interface to the ATEC CIS will carry only items 1, 2, 4, 5, and 8 of the chart. Configuration updates will come via NCE. These will be from an individual TCE, so that there will be one-fifth the number of messages shown in the initial table. Table lists the data flow for the TCP/CIS interface. The average rate is only 0.1032 bps. The most important exchange will be the reports relative to link performance degradation or equipment status. The 150 bps line can send one of these messages per second, making that line quite adequate.

REFERENCES

1. "ATEC-LRIP" Proposal, Honeywell/CSC, Honeywell Avionics Division, Minneapolis, Minnesota, January 6, 1978.

2. "System Specification for Automated Technical Control (ATEC)," Specification Number ATEC 10000, 31 October 1977.

3 "NTC'77 Conference Record," Volume 3, IEEE Publication #77CH1292-2 CSCB, Session #37, 1977.

4. "NCC Operator Interface," Draft Computer Program Development Specification, CDRL Item #B006, Document Control #D-33-13B06-84, DCA Contract #200-C-637, Western Union Telegraph Company, McLean, Virginia.

5. "NCC Data Management," Draft Computer Program Development Specification CDRL Item #B006, Document Control #D-33-13B06-84, DCA Contract #200-C-637, Western Union Telegraph Company, McLean, Virginia.

6. "AUTODIN II Design Plan," Volume II, Document #DIN D-109-13B03-224, DCA Contract Number 200-C-637, Western Union Telegraph Company, McLean, Virginia.

7. "AUTODIN II Design Plan," Volume VIII, Document Control #DIN II D-109-13B03-224, DCA Contract #200-C-637, Western Union Telegraph Company, McLean Virginia, 26 August 1977.

8. "DCA System Performance Specification (Type "A") for AUTODIN II Phase I," November 1977.

9. "DCA System Performance Specification (Type "A") for AUTODIN II Phase I, January, 1977, Revision.

10. "AUTODIN II Phase I Proposal, Part V, Design (Technical) Specification, Subpart 5, Network Control Center", Western Union Telegraph Company, McLean, Virginia.

11. "AUTODIN II Phase I Proposal, Appendix E, NCC Software-Detailed Description", Western Union Telegraph Company, McLean, Virginia.

12. "Augmented AUTOVON Switch Study," Final Report, Volume II (Appendices), Contract #DCA 100-76-C-0041, GTE Sylvania Incorporated, Electronic Systems Group, Communication Systems Division, Needham, MA 02194.

13. "Performance Specification Central Office Communications Automatic AN/TTC-39 ( ) (V)," Specification No. TFB1-1101-0001A, Joint Technical Communications Office, Fort Monmouth, NJ, 7 June 1974.

14. "System Description of Circuit Switch" (of the AN/TTC-39), CDRL B013-I, Contract No. DAAB07-74-C-0339, GTE Sylvania, Electronic Systems Group, Eastern Division, Needham Heights, MA, 31 January 1978.

15. "TCCF Report and Directive Message Protocols", ICD-004, Joint Tactical Communications Office, Fort Monmouth, NJ, 8 October 1976.

16. "Definition of Real-Time Adaptive Control (RTAC) of the Defense Satellite Communications System" Volume IV, Contract No. DCA 100-75-C-0062, Stanford Telecommunications Inc/Systems Control Inc. 30 August 1976.

17. "Definition of DCS/DSCS Control Interfaces", Contract No. DCA 100-76-C-0039, Stanford Telecommunications Inc/Systems Control, Inc., 1 December 1976.

18. "Definition of Terrestrial DCS/DSCS Control Interfaces", Volume I, Contract No. DCA 100-76-C-0039, Stanford Telecommunications Inc, Systems Control, Inc., (Preliminary) July 1977.

19, (S) "Definition of Real-Time Adaptive Control (RTAC) of the Defense Satellite Communications System (DSCS) "(U)", Volume II (RTAC System Summary), Stanford Telecommunications Inc, Contract No. DCA-100-75-0062, 20 August 1976.

20. "System Specification for the Defense Satellite Communications System (DSCS) Control Segment (CS)" SS-CS-100, Stanford Telecommunications Inc., Contract No. DCA 100-76-C-0039, 15 February 1978.

21. "System Segment Specification for the Operational Control Element (OCE) of the Defense Satellite Communications System Control Segment (DSCS/CS)" SS-OCE-110, Stanford Telecommunications Inc., Contract No. DCA-100-76-C-0039, 15 February 1978.

22. "System Segment Specification for the Network Control Element (NCE) of the Defense Satellite Communications System Control Segment (DSCS/CS)" SS-NCE-120, Stanford Telecommunications Inc., Contract No. DCA-100-76-C-0039, 15 February 1978.

23. "System Segment Specification for the Terminal Control Element (TCE) of the Defense Satellite Communications System Control Segment (DSCS/CS)" SS-TCE-140, Stanford Telecommunications Inc., Contract No. DCA-100-76-C-0039, 15 February 1978.

24. "Procedures for Data Transmission between NCE and TCEs via the Control Orderwire Subsystem (COSS)", ICD-CS-2142, Stanford Telecommunications, Inc.

25. ANSI X3534/589 American National Standard for Advanced Data Communication Control Procedures (ADCCP). Independent Numbering, 15 October 1976.

26. Kuczura, A. and Neal, S.R., "The Accuracy of Call-Congestion Measurements for Loss System with Renewal Input", Bell System Technical Journal, Volume 51, No. 10, December 1972, pages 2197-2208.

27. "Channel Reconfiguration Feasibility Model", PR No. C-8-2022, Rome Air Development Center, Griffiss Air Force Base, New York, March 1978.

28. "Unified Network/Traffic Transmission Media Control", Contract No. DCA-100-76-C-0082, Computer Sciences Corporation, Falls Church, VA, August 1977.

29. Analysis of Data Acquired from Government Sources.

30. "Switchboard Telephone Automatic SB-3865 ( ) (P)/TTC", Specification No. TT-B1-1203-0033, Joint Technical Communications Office, Fort Monmouth, NJ, 11 May 1976.

GLOSSARY

ACOC	Area Communications Operations Center
A/D	Analog/Digital
ADC	Automatic Digital Counter
ADCCP	Advanced Data Communications Control Procedure
AFSCF	Air Force Satellite Control Facility
AFSTC	Air Force Satellite Test Center, part of AFSCF
AGC	Automatic Gain Control
AN-FSC-78	Heavy Terminal
AN-GSC/24	Asynchronous Multiplexer
AN-MSC/61	Mobile Terminal
AN-USC/28	Spread Spectrum Modem
ANSI	American National Standards Institute
ASA	Automatic Specturm Analyzer
ASCT	Auxiliary Satellite Control Terminal
ATB	All Trunks Busy
ATEC	Automated Technical Control
AUTODIN	Automatic Data Interchange Network
AUTOSEVOCOM	Automatic Secure Voice Communication Network
AVOW	Analog Voice Orderwire
BC	Block Control
BER	Bit Error Rate
BIS	Baseband Interface Subsystem

BKB	Bookkeeping Block
BPSK	Biphase Shift Keying
bps	Bit per Second
CCC	Critical Control Circuit
CEI	Contract End Item
CESE	Communications Equipment Support Element
CIS	Communications Interface Subsystem (ATEC)
CIT	Controller Interface Terminal
C/kT	Ratio of carrier power to noise spectral destiny
CMC	Clear Mode Control
CODEC	Coder/Decoder
COM	Control Orderwire Master
COMSEC	Communications Security
COS	Control Orderwire Slave
COSS	Control Orderwire Subsystem
CPC	Computer Program Component
CPCI	Computer Program Configuration Item
CPU	Central Processing Unit
CS	Control Segment
CT	Control Terminal
CRT	Cathode Ray Tube
CVSD	Continuously Variable Sloped Delta Modulation
CX-11230	Cable for digital transmission groups
dB	Decibel

dBM	Decibels referenced to one milliwatt of power
DBMS	Data Base Management System
DCA	Defense Communications Agency
DCAOC	Defense Communications Agency Operation Center
DCS	Defense Communications System
DEFCON	Defense Condition
DNVT	Digital Non-Secure Voice Terminal
DRAMA	Digital Radio and Multiplex Acquisition
DSCS	Defense Satellite Communication System
DSCS/CS	Defense Satellite Communications System Control Segment
DSVT	Digital Subscriber Voice Terminal
DT&E	Development Test and Evaluation
DTG	Digital Trunk Group
DTMF	Dual Tone Multiple Frequency - An AUTOVON signalling method
DTS	Diplomatic Technical Service
EC	Earth Coverage
ECCM	Electronic Counter Counter Measure
EIA	Electronics Industries Association
EIRP	Effective Isotropic Radiated Power
EMC	Electromagnetic Compatibility
EOW	Engineering Orderwire
EPAC	Eastern Pacific Ocean (satellite network)
ESS4	Electronic Switching System #4 - Bell System Digital Tandem Switch

FDMA	Frequency Division Multiple Access
FED-STD	Federal Standard
FIFO	First In/First Out
GFE	Government Furnished Equipment
GFP	Government Furnished Property
GHz	Gigahertz
GMF	Ground Mobile Forces
G/T	Ratio of Antenna Receiving Gain to Temperature
HAZCON	Hazardous Condition - A DCS term
HIPO	Hierarchial Input Processing Output
HOL	High Order Language
HP	Historical Profile
HPA	High Power Amplifier
HSD	High Speed Data
HT	Heavy Terminal
ICD	Interface Control Drawing
ICD-004	Protocol Specification for TRI-TAC
ICF	Interconnect Facility
ICU	Interactive Control Unit (AUTODIN II)
IF	Intermediate Frequency
IMU	Inter Matrix Unit
IND	Indian Ocean (satellite network)
I/O	Input/Output
IRIS	IF-RF Interface Subsystem

JLE	Jammer Location Electronics
Kbps	Thousands bits per second
KDP	Keyboard/Display/Printer
KG	Keying Generator
KVDT	Keyboard Video Display Terminal
KY-3	Encryption Device
LANT	Atlantic Ocean
LOW	Link Orderwire
LRU	Line Replaceable Unit
MBA	Multi-Beam Antenna
Mbps	Megabits per second
MCCU	Multiple Channel Control Unit (AUTODIN II)
M_{cT}	Mean Corrective Time
M/D/1	A Markov arrival time, discrete service time, single server queue
MF2/6	Multiple Frequency, 2 out of 6 tones; siganlling method used in AUTOVON.
MHz	Megahertz
MILDEP	Military Department
MIL-STD	Military Standard
MMI	Man Machine Interface
MSF	Multiplex Signal Format
MTBF	Mean Time Between Failure
MTR	Mean Time to Restore
MTTR	Mean Time to Repair

NATO	North American Treaty Organization
NCC	Network Control Center (AUTODIN II)
NCE	Network Control Element
NCP	Network Control Processor
NCS	Nodal Control Subsystem (ATEC)
NCT	Network Control Terminal
NRE	Network Reconfiguration Engineering (AUTODIN II)
OCE	Operational Control Element
OCP	Operational Control Processor
OMS	Operation and Maintenance Subsystem
OT&E	Operational Test and Evaluation
PABX	Private Automatic Branch Exchange
PBER	Pseudo Bit Error Rate
PBX	Private Branch Exchange
PCM	Pulse Code Modulation
PM	Performance Monitoring
PMP	Performance Monitoring Program
PN	Pseudo Noise
PN/TDMA	Pseudo Noise/Time Division Multiple Access
PSN	Packet Switching Node
PTF	Patch and Test Facility
QPSK	Quadraphase Shift Keying
RF	Radio Frequency
RFO	Reason for Outage

RSJ	Register Sender Junctor
RSL	Received Signal Level
RSS	Received Signal Strength
RTS	Remote Tracking Station, associated with the AFSCF
SATCOM	Satellite Communications
SB-3865	The user concentrating switch for upgraded AUTOVON/ AUTOSEVOCOM II.
SCAU	SYSCON Channel Acquisition Unit
SCCE	Satellite Configuration Control Element
SCCU	Single Channel Control Unit
SCM	Switch Control Module
SCR	Silicon Controlled Rectifier
SCS	Sector Control Subsystem (ATEC)
SDMX	Space Division Matrix
SF	Single Frequency
SMS	Satellite Monitoring Subsystem
SNCC	Subnetwork Control Center; a copy of the NCC serving European AUTODIN only.
SNCE	Subnet Control Element
SSMA	Spread Spectrum Multiple Access
SSME	Spread Specturm Modem Equipment
STED	Seeley Trunk Encryption Device (SB-3865)
SYSCON	System Control
TAC	Terminal Access Controller
TBD	To be determined

TBP	To be provided
TBS	To be specified
TCC	Transmission Control Code (AUTODIN II)
TCCF	Tactical Communications Control Facility
TCE	Terminal Control Element
TCP	Terminal Control Processor
TDM	Time Division Multiplex
TDMA	Time Division Multiplex Access
TDMX	Time Division Matrix
TLC	Traffic Load Control
TM	Test Mode
TRI-TAC	The tactical communications system currently under development.
TTC-39	The nodal circuit switch for upgraded AUTOVON/AUTOSEVOCOM II.
TTY	Teletype
TX	Transmission
UK	United Kingdom
ULS	Unit Level Switch
VDCU	Voice Data Channel Unit
VOW	Voice Orderwire
WF-16	Fieldwire for telephone installations.
WOFR	WWOLS Output Formatting Routines
WPAC	Western Pacific Ocean (satellite network)
WWOLS	World Wide On-Line System